Wireless Connectivity

Texas Instruments

RF ICs and proprietary protocols for the Sub-1 GHz and 2.4 GHz frequency bands, 6LoWPAN, ANT™, *Bluetooth*®, *Bluetooth* low energy, GPS, IEEE 802.15.4, PurePath™ Wireless audio, RFID/NFC, Wi-Fi®, ZigBee® PRO, ZigBee RF4CE

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4Q 2014

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With the industry's broadest wireless connectivity portfolio TI offers cost-effective, low-power solutions for short-range, long-range, mesh and IP networks, as well as personal area networks and more in the Internet of Things. TI SimpleLink™ solutions leverage more than a decade of wireless expertise and are designed to enable easier and faster development of RF applications. The SimpleLink portfolio supports technololgies: Wi-Fi®, *Bluetooth*®, *Bluetooth* low energy, ANT™, ZigBee® PRO, IEEE 802.15.4, ZigBee RF4CE, NFC/RFID, 6LoWPAN and PurePath™ Wireless audio, GPS as well as a selection of RF ICs and proprietary protocols for the Sub-1 GHz and 2.4 GHz frequency bands. TI provides an ecosystem of support such as development tools, technical documentation, reference designs, application samples, customer support and services from the Texas Instruments Design Network and university programs.

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Introduction

The right wireless connectivity solution

Whatever type of wireless technology you need for your next Internet of Things (IoT) designs, TI can help you find the right one for your application.

With the industry's broadest wireless connectivity portfolio, TI supports more than a dozen wireless technologies for:

- 802.15.4 standards-based mesh and IP networks
- Personal area networks
- Proprietary RF sub-1 GHz
- Proprietary RF 2.4 GHz
- RFID/NFC
- GPS

Connecting to the Internet of Things and more

Analysts estimate that the IoT is quickly growing with the expectation of 50 billion connected devices by 2020. TI is connecting the IoT now with the industry's broadest portfolio of embedded wireless connectivity technologies, microcontrollers, processors and analog solutions. Examples of how IoT-ready connectivity is used:

- Alarm, security and active/passive RFID/NFC
- Automotive
- Home automation and lighting
- Metering/smart energy
- Portable consumer
- Portable enterprise
- Consumer medical and health
- Remote controls
- Wireless audio

SimpleLink™ solutions make wireless design easier

SimpleLink self-contained solutions were designed to simplify wireless development and certification by minimizing the amount of RF expertise you need to wirelessly enable a wide range of applications. TI offers SimpleLink solutions for multiple wireless technologies including Wi-Fi®, ZigBee®, 6LoWPAN, ANT™ and GPS with an expanding portfolio to come.

Wireless solutions optimized for TI's embedded processing portfolio

Decrease your development time with TI's wireless technologies pre-integration and TI Embedded Processing solutions.

Our connectivity solutions are designed for the industry's broadest embedded processing portfolio – from high-performance processors to low power MCUs.

Resources that make development easy

Our solutions are paired with resources that make development fast and easy and reduce time-to-market.

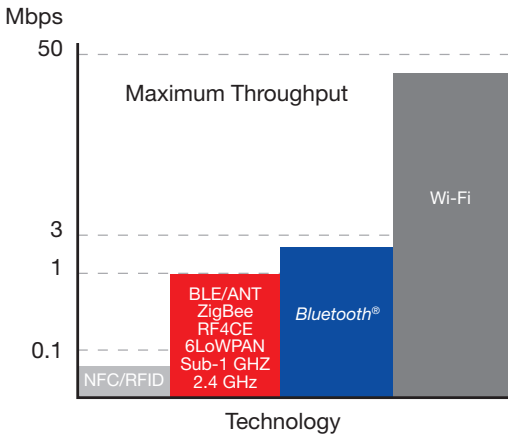
TI's out-of-the-box development tools will get you quickly started. Through TI you'll have access to a broad variety of cost-effective development tools, reference designs and supporting application and design notes.

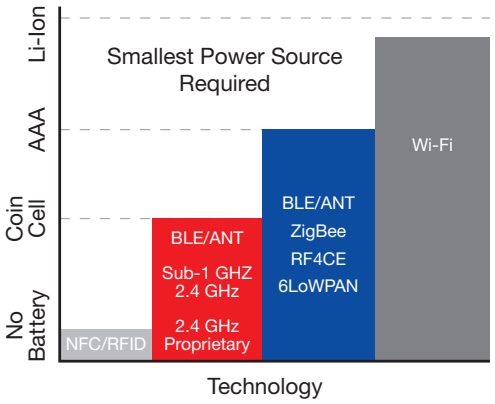
Get answers to your design questions from the TI design experts through our interactive online E2E™ community.

If you need help to speed up your application development, TI has an extensive network of third parties to help accelerate your design. The network consists of recommended companies, RF consultants, and independent design houses that provide a series of hardware module products and design services.

Getting started: Which wireless connectivity technology is right for your design

Finding the best connectivity fit for your application or system is a must and can be daunting. Below are two basic considerations – Maximum throughput and power source. For more information on how to get started, go to *www.ti.com/wirelessconnectivity* and learn more.





Wi-Fi® Overview

Wi-Fi IEEE 802.11 a/b/g/n

Wi-Fi continues to effectively penetrate the wireless market with an installed base of over 3.5B units with an annual shipment rate exceeding a billion units. Nine out of 10 Americans surveyed in a consumer poll said they would rather do without Starbucks for a year than give up their Wi-Fi connection! It is easy to see how the Internet of Things (IoT) is expected to grow to 50 billion connected devices by 2020.

Application areas

- Medical devices and remote patient monitoring
- Consumer devices (tablets, e-books, media players), web browsing, Internet connectivity, and streaming multimedia
- Industrial and home automation, remote monitoring, controlling, data-logging and diagnostics
- Smart machines
- Video conferencing
- Security and surveillance

How does Wi-Fi technology work?

Wi-Fi networks use radio technologies based on the IEEE 802.11a, 802.11b, 802.11g and 802.11n to provide secure, reliable, fast wireless connectivity. Wi-Fi networks operate in the unlicensed 2.4- and/or 5-GHz radio bands at rates of 54 Mbps or greater. They can provide real-world performance similar to the basic 10BaseT wired Ethernet networks. For more information on Wi-Fi technology, visit *www.wi-fi.org*.

Why TI Wi-Fi?

Texas Instruments is the world's leading supplier of Wi-Fi products for portable, battery-powered products leveraging nearly a decade of experience and eight generations of products which are optimized for the needs of personal technology and handheld products for the IoT. TI is also the market leader in combined wireless products such as the pre-certified, preWiLink™ 8 module (single-chip Wi-Fi/*Bluetooth*®/*Bluetooth* low energy device) which further solve issues such as coexistence, antenna sharing in size-constrained devices, cost and power consumption.

TI enables simple Wi-Fi connectivity with the self-contained SimpleLink™ CC3000, which allows very short design cycles by eliminating the need for extensive RF and Wi-Fi expertise.

SimpleLink™ Wi-Fi® CC3100/CC3200

Easy embedded Wi-Fi Internet-on-a-chip™ solutions for the Internet of Things

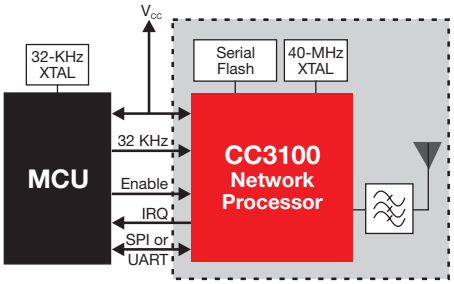
CC3100/CC3200

Learn more at: **www.ti.com/simplelinkwifi**

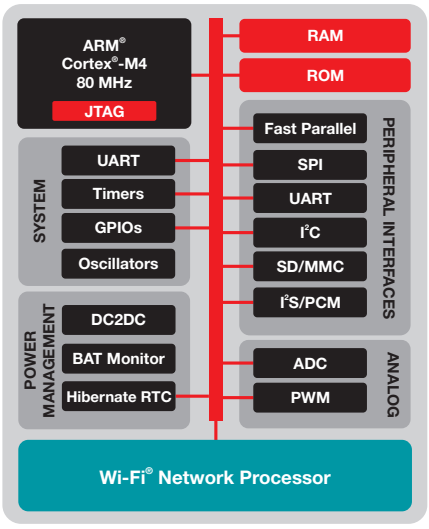
TI makes connectivity even easier with the next-generation SimpleLink Wi-Fi solutions. The product family features Internet-on-a-chip solutions to solve industry challenges in designing a broad array of embedded Internet of Things (IoT) applications. The platforms enable:

- Easier Wi-Fi development
- Secure and fast connection to the cloud
- Low power for battery-operated designs/products
- Growing cloud ecosystem for quicker time to market and long-term platform

Two options are available, both pin-to-pin compatible.



CC3100 block diagram.



CC3200 block diagram.

CC3100 Wireless Network Processor

The CC3100 device is a Wi-Fi, self-contained network processor with on-chip web server and embedded TCP/IP stack that connects easily to any low-cost and low-power microcontroller (MCU) such as the MSP430F552, thanks to a simple UART or SPI driver and host memory footprint as low as 7kB of code to reside on the MCU. Hardware design is made easy for space-constrained boards with a small 64-pin 9×9-mm QFN package. Certified modules are coming soon.

CC3200 Wireless MCU

The SimpleLink Wi-Fi CC3200 solution

The industry's first Wi-Fi wireless microcontroller with user-dedicated MCU capitalizes on the CC3100 benefits and integrates a high-performance 80-MHz ARM® Cortex®-M4 MCU and peripherals. Developers can fully access the MCU portion with 200kB of application code available fully independent from the Wi-Fi processing. The peripheral set includes parallel camera, I²S audio, SDMMC, ADC, SPI, UART, I²C, PWM, I/Os, built-in power management and RTC enabling many MCU embedded applications to connect to the cloud. Certified modules will be available.

Applications

- Home automation
- Home appliance
- Safety and security
- Smart energy
- Industrial M2M communication
- Wireless audio streaming

Get started with development tools

- Both devices are supported with low-cost development boards and by a software development kit (SDK) including software drivers, sample applications, API guide, user documentation and a world-class support E2E™ community.

Kit name	Description	When to buy this?
SimpleLink Wi-Fi C3200 Internet-on-a-chip™ wireless microcontroller (MCU)		
CC3200-LAUNCHXL $29.99 USD	• CC3200 Launchpad • Single-chip Internet of Things solution with integrated MCU	Want to use Wi-Fi® wireless MCU – single-chip Internet-on-a-chip
SimpleLink Wi-Fi CC3100 Internet-on-a-chip wireless network processor		
CC3100BOOST-CC31XXEMUBOOST-EXP430F5529LP $49.99 USD	• CC3100 BoosterPack + Advanced emulation board + MSP430F5529 Launchpad	Want to evaluate all CC3100 sample apps, using TI's ultra-low-power MSP430™ MCU family
CC3100BOOST-CC31XXEMUBOOST $36.99 USD	• CC3100 BoosterPack + flashing and advanced debug capability • Compatible LaunchPads (sold separately)	Want to use CC3100 with any other MCU. Need one EMUBOOST board for flashing, using radio tool, using SimpleLink Studio (MCU development on PC) or advanced debug

WiLink™ 8 module solutions

2.4-GHz Wi-Fi + *Bluetooth*®/*Bluetooth* low energy pre-integrated modules

WL1801, WL1805, WL1831, WL1835

Learn more at: **www.ti.com/wilink8**

Overview

TI's newest WiLink 8 module family enables FCC/IC/ETSI-compliant and fully integrated Wi-Fi and *Bluetooth* technology solutions for the Internet of Things with high throughput and extended range. WiLink 8 solutions provide certified Wi-Fi and *Bluetooth*/*Bluetooth* low energy co-existence in a power-optimized design.

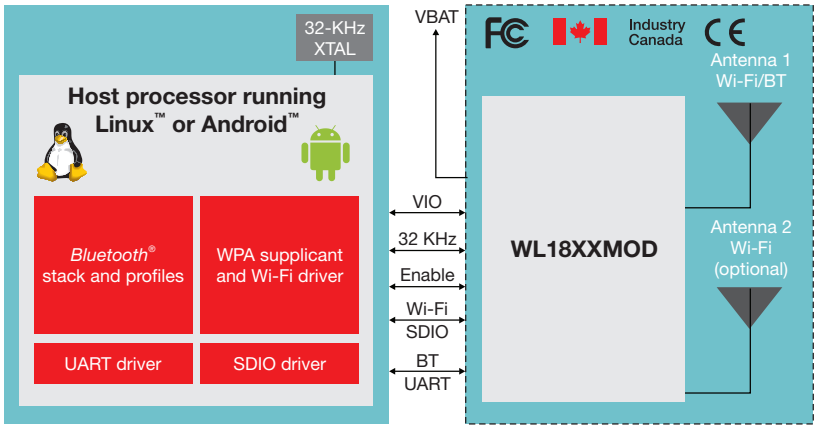
WiLink 8 is provided as certified modules by TI to reduce development time, lower manufacturing costs, save board space and minimize RF expertise required. Additionally, Linux™ and Android™ drivers for Wi-Fi and *Bluetooth* are pre-integrated with software development kits for TI's AM335x and other Sitara™ microprocessors.

Key features and benefits

- High-performance Wi-Fi
  - 802.11 b/g/n 2.4-GHz Radio/Baseband/MAC
  - 20- and 40-MHz channels
  - 2×2 MIMO (2.4 GHz)
  - Up to 110 Mbps (UDP) of throughput
  - MRC for extended range of 1.4× (2.4 GHz)
  - Station and soft access point
    - Wi-Fi direct multi-channel multi-role
  - Personal and enterprise security
  - Linux™ and Android™ drivers
- Dual-mode *Bluetooth*
  - *Bluetooth* and *Bluetooth* low energy (BT 4.0 compliant)
  - Wi-Fi/*Bluetooth* single antenna co-existence
- Built-in power management
- Advanced low-power modes
- Host interfaces
  - SDIO for Wi-Fi and UART for *Bluetooth*
- Temperature range: – 20°C to +70°C
- Small form factor: 13.4 × 13.3 × 2 mm

Applications

- Internet of Things
- Multimedia
- Home electronics



WiLink 8 block diagram.

- Home appliances and white goods
- Industrial and home automation
- Smart gateway and metering
- Video camera and security

WiLink resources

- Learn more: *www.ti.com/wilink8*
- E2E™ Forum: *www.ti.com/wiconforum*
- WiLink 8 Wiki: *www.ti.com/wilink8wiki*

TI Modules

Product Number	Wi-Fi®			*Bluetooth*® v4.0	FCC/IC/ETSI Certified
	802.11bgn	MIMO	MRC		
WL1801MOD	•				•
WL1805MOD	•	•	•		•
WL1831MOD	•			•	•
*WL1835MOD	•	•	•	•	•

**WL1835MOD is available for sample through TI eStore and authorized distributors.*

Development Tools and Software

Product Number	Description	Availability
WL1835MODCOM8	WL1835-based evaluation board compatible with the Sitara™ AM335x EVM as well as several other TI EVMs and reference designs	TI eStore and authorized distributors
WL1835MOD Cape	WiLink 8 module-based cape offered by CircuitCo for fast development with BeagleBone Black and BeagleBone open source computer	BoardZoo.com and CircuitCo distributors

Other tools

- TI provides a fully integrated and validated WiLink 8 add-on software for Sitara AM335x Linux ezSDK via *www.ti.com/wilink8wiki*
- TI's SmartConfig™ technology is a one-step Wi-Fi setup process that allows multiple in-home devices to connect to Wi-Fi networks quickly – *www.ti.com/tool/smartconfig*

ZigBee Overview

ZigBee/IEEE 802.15.4

ZigBee is a standards-based technology for remote monitoring, control and sensor network applications. The ZigBee standard was created to address the need for a cost-effective, standards-based wireless networking solution that supports low data-rates, low-power consumption, security, and reliability.

ZigBee supports self-healing mesh networking which is a decentralized network topology very similar to the Internet. It allows nodes to find new routes throughout the network if one route fails, making ZigBee a robust wireless solution.

Application areas

A technology specifically targeted for wireless sensor networks, ZigBee 802.15.4 can be used in any monitoring and control application that requires a wireless link. The primary target markets are:

- Home, building and industrial automation
- Smart wireless lighting control and LED bulbs
- Home control/security
- Medical/patient monitoring
- Logistics and asset tracking
- Sensor networks and active RFID
- Advanced metering/smart energy
- Commercial building automation
- Energy harvesting

Why TI ZigBee?

Texas Instruments is a founding member of the ZigBee Board of Directors. Unlike other hardware suppliers that outsource their ZigBee stack development, our software engineering team delivers golden unit certified platforms which are the benchmark for other developer companies to test against. TI is the lead technical editor for the next generation IP based protocol stack. TI's ZigBee solutions include:

- Cortex®-M3 based System-on-Chip (SoC) is targeted for dual stack SE and HA applications offering hardware security acceleration for fast commissioning.
- TI provides complete and free software solution on various platforms (8051 and Cortex-M3 SoCs, ultra-low power MSP430™)
- TI provides extensive development tools, application support, reference designs
- TI is the ZigBee market leader and #1 in 802.15.4 and shipped the first 802.15.4 chip on the market (CC2420)
- TI brings ZigBee technology to smartphones as mobile smart energy display
- TI had the first IEEE 802.15.4 radio and has a continued solid roadmap with focus on ZigBee

Three paths to ZigBee

TI offers three ZigBee-compliant platforms, built on the CC2538 system-on-chip (SoC), CC2530 SoC and the CC2520+MSP430™ two-chip solution.

- The CC2538 ARM® Cortex-M3 SoC is the industry's first 512-kB Flash device with enough on-chip memory to support onboard over-the-air download.
- The ZigBee second-generation CC2530 system-on-chip (SoC) is a ZigBee golden unit that is targeted for low-power applications and small-form-factor designs.
- By running the CC2530 as a ZigBee Network Processor, it will run the ZigBee stack and handle all the network processing, offloading a separate host processor that runs the main application. The host processor communicates with the CC2530 over a serial interface. This partitioning option allows the designer to keep the ZigBee application profile and any other applications on the main processor.
- The second-generation CC2520 IEEE 802.15.4 transceiver can be used with the MSP430 MCU and Tiva™ suite of ARM Cortex-M3 technology. It is recommended for designers who want additional Flash and RAM.

		SoC small footprint, high integration, low cost	**Co-processor** flexible, easy to use and reduced time to market	**Dual-chip** ultra-low power or high performance
Complete ZigBee Solutions	Application	**CC2530** or **CC2538**	Any MCU (**MSP430**™, **Tiva**™) Any MPU (**Sitara**™)	**MSP430**
	Protocol stack		CC253x-based coprocessors with UART/SPI/USB interface: • Stack and application profile • Protocol stack • MAC only 	 Three paths to ZigBee
	Radio			**CC2520**
	RF front end (optional)	**CC2590 / CC2591**	**CC2590 / CC2591**	**CC2590 / CC2591**

TI's three paths to ZigBee.

www.ti.com/zigbee

ZigBee Light Link

Overview

The world of wireless lighting control has seen a dramatic shift from custom or proprietary lighting solution as efficient and low cost solutions have been introduced to the general market. Consumers recognize the value of convenience, security, and comfort that wireless devices bring to the home or office. The barrier to these systems in the past has been that most product manufacturers do not provide a system that allows interoperability among different lighting control vendors.

Designers can create an easy to use lighting control solution using ZigBee light link (ZLL) profile on the Texas Instruments Z-Stack Pro platform. ZLL is designed to run on the CC2530 product family. ZLL was created to save time, money and installation frustration by providing a simple easy to install network of lights, switches, occupancy sensors, daylight sensors that can be controlled by a mobile device such as an tablet and mobile phone as illustrated in Figure 1.

TI ZigBee Light benefits

- Ease of set-up/installation
  - No tools required
  - No new wires to be installed, great for retrofit projects
  - No special devices needed
- Scalable over time to easily add your existing luminaries or new light points to the system
- System components in a reliable secure mesh network which allows communication to be safely relayed by multiple individual network nodes
- Flexibility of movement to allow you to change the positioning of your components wherever you want
- Control of lights from anywhere you like
- Enhanced selection of lighting levels (including on/off) and ambiances for a single or group of lights stored and recalled by the press of a button

What makes ZigBee Light Link valuable?

Lighting control requires low cost technology, long battery life capability, reliable network performance and system security. This is why the ZigBee Light Link solution is based on ZigBee technology.

- This system does not require a coordinator node, or other special devices
- All components in the network are on a similar hierarchical level and can easily be added to or removed from the network without affecting system functionality or integrity

Figure 1 – Low-power RF lighting control

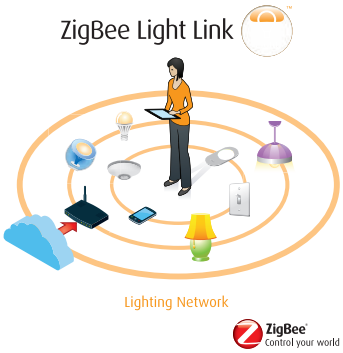


Figure 2. ZigBee Light Link

Courtesy of ZigBee Alliance

How does TI ZigBee Light Link work?

With Light Link, adding or removing lamps is very easy and robust. Contrary to other networking solutions, it does not matter which lamp is installed first, or whether other lamps in the network are switched on or off. With ZigBee Light Link, adding a new lamp at a remote location is as easy as adding a lamp nearby in range. Figure 2 demonstrates the solution.

Only TI can provide you with one stop shopping for your wireless lighting projects. Smart phones, tablets and PCs via bridging devices can control lighting products based on TI. Wireless control is possible via direct control such as the key fob, remote control and wireless wall switch or occupancy sensor. ZigBee Light Link can also be controlled remotely using a tablet mobile app via a Wi-Fi to ZigBee gateway. Added digital functionality can add wake up features or time phased multi room on/off lighting for vacation mode security.

TI gets you into the Smart Lighting market NOW!

ti.com/ZigBee

CC2538

2.4-GHz IEEE 802.15.4 ZigBee System-on-Chip Solution
CC2538

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC2538**

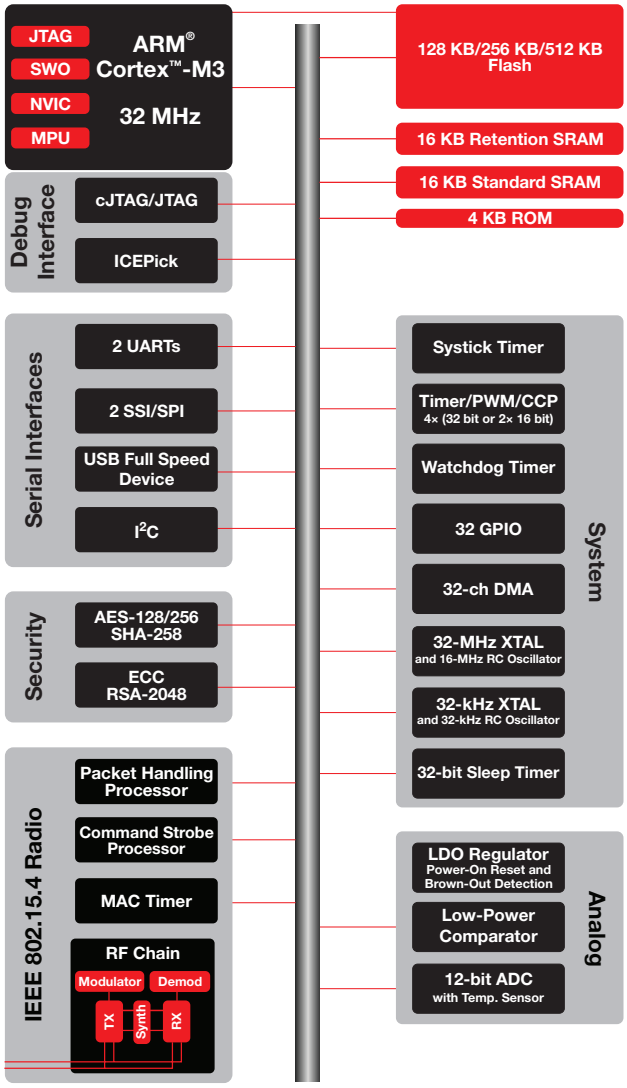
The CC2538 is a cost-effective, low-power, and full System-on-Chip (SoC) solution specifically tailored to IEEE 802.15.4 point-to-point, star, and ZigBee PRO mesh network advanced applications as well as ZigBee IP Smart Energy 2.0 applications and 6LoWPAN products.

The CC2538 combines a fully integrated high-performance RF transceiver with an industry-standard enhanced Cortex®-M3 MCU, Flash, RAM and other powerful supporting features and peripherals.

The CC2538 comes in multiple memory and feature options, among them 256KB/512KB Flash memory, 16KB/32KB RAM memory and multiple security features such as AES engine with 128-, 192-, 256-bit key support and Public Key Accelerator ECC and RSA-2048.

Key features

- Future proof memory sizes
  - Up to 512 KB TSMC Flash to enable on-chip OTA
  - Up to 32 KB RAM (16 KB with retention) to comfortably implement ZigBee IP routers
- Lower-power IEEE 802.15.4 radio
  - 20 mA in Rx
  - 24 mA in Tx @ 0 dBm
- Powerful MCU system
  - 1.2 µA sleep current with RTC with 120 µs wake up for long battery life
  - Robust and proven power management system
- Capable security core ready for ZigBee SE 2.0:
  - AES engine with 128, 192, 256-bit key support
- CCM, GCM, CTR, CBC-MAC, ECB modes of operation
- SHA-256 hash function
- Secure key storage memory
- High throughput
  - Public key accelerator
- ECC and RSA-2048
- Side channel attack protection against timing and power attacks



CC2538 system diagram.

Benefits

- Supports ZigBee PRO Mesh, ZigBee IP Mesh, advanced ZigBee profiles, ZigBee RF4CE, 6LoWPAN, and all 802.15.4-based solutions
- Excellent receiver sensitivity and programmable output power
- Very low current consumption in RX, TX, and multiple low-power modes ensure long battery lifetime
- Best-in-class selectivity and blocking performance, with lowest packet error rate. Suited for battery applications

Applications

- Meters and home area network – Smart Energy 1.x/Smart Energy 2.x
- Automated meter reading
- Lighting networks
- Remote controls
- Home/building automation
- Consumer products
- Industrial control and monitoring
- Low-power wireless sensor networks

CC2520

RF Transceiver for IEEE 802.15.4/ZigBee
CC2520

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC2520**

The CC2520 is TI's second generation ZigBee/IEEE 802.15.4 RF transceiver for the 2.4-GHz unlicensed ISM band. This chip enables industrial-grade applications by offering state-of-the-art noise immunity, excellent link budget, operation up to 125°C and low-voltage operation.

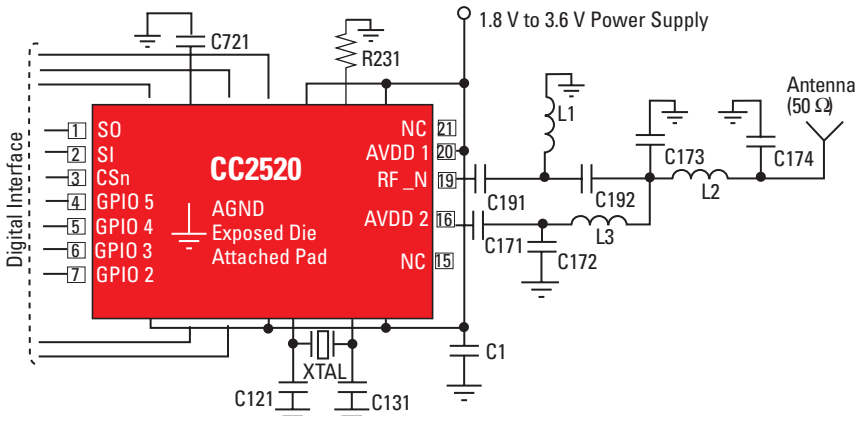
In addition, the CC2520 provides extensive hardware support for packet handling, data buffering, burst transmissions, data encryption, data authentication, clear channel assessment, link quality indication and packet timing information. These features reduce the load on the host controller.

Key features
- State-of-the-art noise immunity with minimum 48-dB adjacent channel rejection
- Excellent link budget (103 dB)
- Extended temp range (–40°C to +125°C)
- Extensive IEEE 802.15.4 MAC hardware support
- CC2420 interface compatibility mode
- AES-128 security module

Benefits
- Enables industrial applications in the 2.4-GHz ISM band
- Excellent coexistence with *Bluetooth*® and Wi-Fi®
- Hardware support to offload MCU

Applications
- Industrial monitoring and control
- Home and building automation
- Low-power wireless sensor networks
- Set-top boxes and remote controls

Development tools and software
- CC2520DK Development Kit
- Z-Stack™ software
- TIMAC
- SimpliciTI™ software protocol



CC2520 application circuit.

General Characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2394	—	2507	MHz
Data rate	—	250	—	kBaud
Operating voltage	1.8	—	3.6	V
Operating temperature	–40	—	125	°C
Output power	–18	—	5	dBm
RX mode				
Receiver sensitivity	—	–98	—	dBm
Adjacent channel rejection, +5 MHz	—	49	—	dB
Adjacent channel rejection, –5 MHz	—	49	—	dB
Adjacent channel rejection, +10 MHz	—	54	—	dB
Adjacent channel rejection, –10 MHz	—	54	—	dB
Current consumption				
Current consumption, RX	—	22	—	mA
Current consumption, TX, +5 dBm	—	33	—	mA
Current consumption, TX, 0 dBm	—	25	—	mA
Current consumption, power down	—	<1	—	µA

CC2530

2.4-GHz IEEE 802.15.4/ZigBee/RF4CE System-on-Chip Solution
CC2530

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC2530**

The CC2530 is a cost-effective, low-power, and true System-on-Chip (SoC) solution specifically tailored to IEEE 802.15.4 point-to-point and star or ZigBee PRO mesh network applications.

The CC2530 comes in four different versions: CC2530-F32/64/128/256, with 32/64/128/256-KB Flash memory respectively, and combines a fully integrated high-performance RF transceiver with an industry-standard enhanced 8051 MCU, 8-KB RAM and other powerful supporting features and peripherals.

Key features

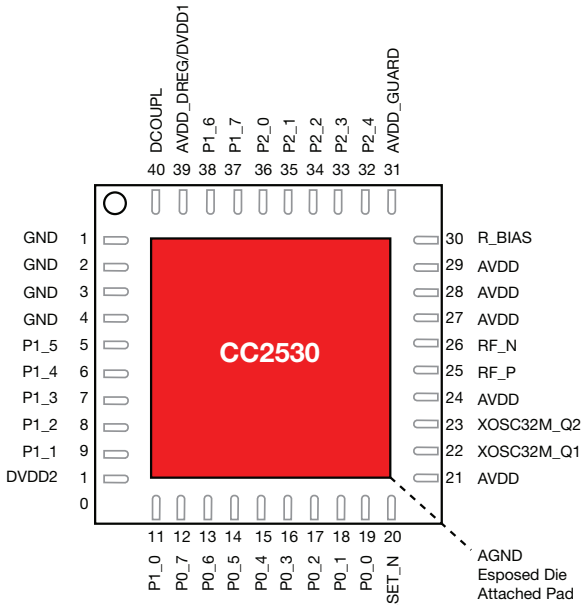
- Up to 256-KB Flash with 20K erase cycles to support over-the-air updates, large applications
- 8-KB RAM for more complex applications and ZigBee profiles
- Programmable output power up to +4.5 dBm
- Less than 1-µA current consumption in power down with sleep timer running
- Includes powerful address recognition and packet processing engine

Benefits

- Supports ZigBee PRO, ZigBee RF4CE, 6LoWPAN, and all 802.15.4-based solutions
- Excellent receiver sensitivity and programmable output power
- Very low current consumption in RX, TX, and multiple low-power modes ensure long battery lifetime
- Best-in-class selectivity and blocking performance, with lowest packet error rate. Suited for battery applications.

Applications

- Smart energy/automated meter reading
- Remote controls
- Home/building automation
- Consumer products
- Industrial control and monitoring
- Low-power wireless sensor networks



CC2530 package.

General Characteristics

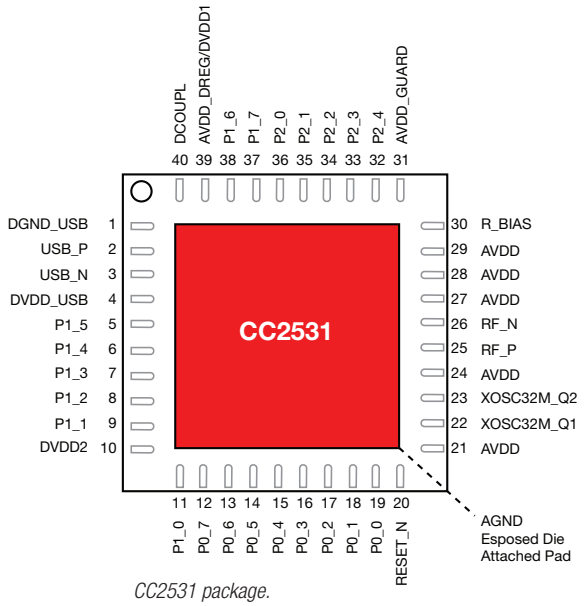
Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400	—	2483.6	MHz
Operating temperature range	–40	—	125	°C
Operating supply voltage	2.0	—	3.6	V
Radio bit rate	—	250	—	kBaud
Receiver sensitivity	—	–97	—	dBm
Adjacent channel rejection	—	49/49	—	dB
Alternate channel rejection	—	57/57	—	dB
Blocking	—	57/57	—	dB
Nominal output power in TX mode	—	+4.5	—	dBm
Current consumption				
MCU active and RX mode	—	25	—	mA
MCU active and TX mode, +4 dBm	—	34	—	mA
Power mode 1	—	105	—	µA
Power mode 2	—	1	—	µA
Power mode 3	—	0.4	—	µA
Wake-up and timing				
From power mode 2 or 3 to active	—	120	—	µs
From active to RX or TX	—	192	—	µs

CC2531

2.4-GHz USB-Enabled IEEE 802.15.4/ZigBee/RF4CE System-on-Chip Solution
CC2531

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC2531**

The CC2531 is a USB-enabled SoC solution for IEEE 802.15.4, ZigBee PRO and RF4CE applications which enables USB dongles or USB upgradable network nodes to be built with low total bill-of-material costs. The CC2531 combines the performance of a leading RF transceiver with an industry-standard enhanced 8051 MCU, in-system programmable Flash memory, 8-KB RAM, and many other powerful features. Combined with the golden-unit-status (ZigBee PRO) from TI, the CC2531 provides a robust and complete ZigBee PRO dongle for firmware upgradable network node.



CC2531 package.

Key features

- Up to 256 KB Flash / 8-KB of RAM
- Excellent link budget (101.5 dB)
- 49dB adjacent channel rejection (best in class)
- Four flexible power modes
- Extended temperature range: –40 to +125°C
- AES-128 security module
- Fully compatible with the CC259x range extenders

USB

- USB 2.0 certified full speed device (12 Mbps)
- 5 highly flexible endpoints
- 1-KB dedicated FIFO
- No 48-MHz crystal required
- Certified CC2531 USB dongle reference design

Benefits

- 2× Flash over closest competitor
- Supports ZigBee PRO, ZigBee RF4CE, and more
- 400m+ LOS range with CC2530EM dev boards
- 12dB better than closest competitor, filters interference from a jammer over 4× closer
- Lowest current consumption power down mode for long battery life low duty-cycle applications
- Widest temperature range for superior robustness
- Efficient security takes up little Flash or MCU cycles
- Reduced part list and lower BOM cost

Benefits (continued)

- Ideal for gateway or bridge device
- Simple low-cost solution to 1000+ meter range
- Allows smaller PCB to help miniaturize product
- Provides legacy IR support with no added cost

Applications

- Home, building and industrial automation
- Energy harvesting
- Home control/security
- Medical/patient monitoring
- Logistics and asset tracking
- Sensor networks and active RFID
- Advanced metering/smart energy
- Commercial building automation

General Characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400	—	2483.6	MHz
Operating temperature range	–40	—	125	°C
Operating supply voltage	2.0	—	3.6	V
Radio bit rate	—	250	—	kBaud
Receiver sensitivity	—	–97	—	dBm
Adjacent channel rejection	—	49/49	—	dB
Alternate channel rejection	—	57/57	—	dB
Blocking	—	57/57	—	dB
Nominal output power in TX mode	—	+4.5	—	dBm
Current consumption				
MCU active and RX mode	—	25	—	mA
MCU active and TX mode, +4 dBm	—	34	—	mA
Power mode 1	—	105	—	µA
Power mode 2	—	1	—	µA
Power mode 3	—	0.4	—	µA
Wake-up and timing				
From power mode 2 or 3 to active	—	120	—	µs
From active to RX or TX	—	192	—	µs

Z-Stack™ – ZigBee® Protocol Stack

Z-Stack™ – TI's industry-leading ZigBee protocol stack

Z-Stack is TI's protocol stack for a growing portfolio of IEEE 802.15.4 products and platforms. Z-Stack is a certified ZigBee-Compliant Platform for the ZigBee 2012 specifications on the C2538 System-on-Chip (SoC), CC2530 SoC and MSP430+CC2520 transceiver. Z-Stack supports the Smart Energy, Home Automation, Light Link, Building Automation and Health Care application profiles. The latest ZigBee PRO stack is downloadable from the TI web site without any royalty charge.

Key features

- A fully compliant ZigBee PRO feature set on the CC2530 and CC2538 family of SoCs and an extensive family of MSP430™ microcontrollers coupled with the CC2520 transceiver
- A range of sample applications including support for the ZigBee Smart Energy, ZigBee Home Automation and ZigBee Light Link Profiles
- Over The Air download support
- Incorporated support for the CC2591 (*www.ti.com/cc2591*) and CC2590 (*www.ti.com/cc2590*), the latest RF front ends which support regional requirements for +20dBm and +14dBm transmit power and improved receive sensitivity

Benefits

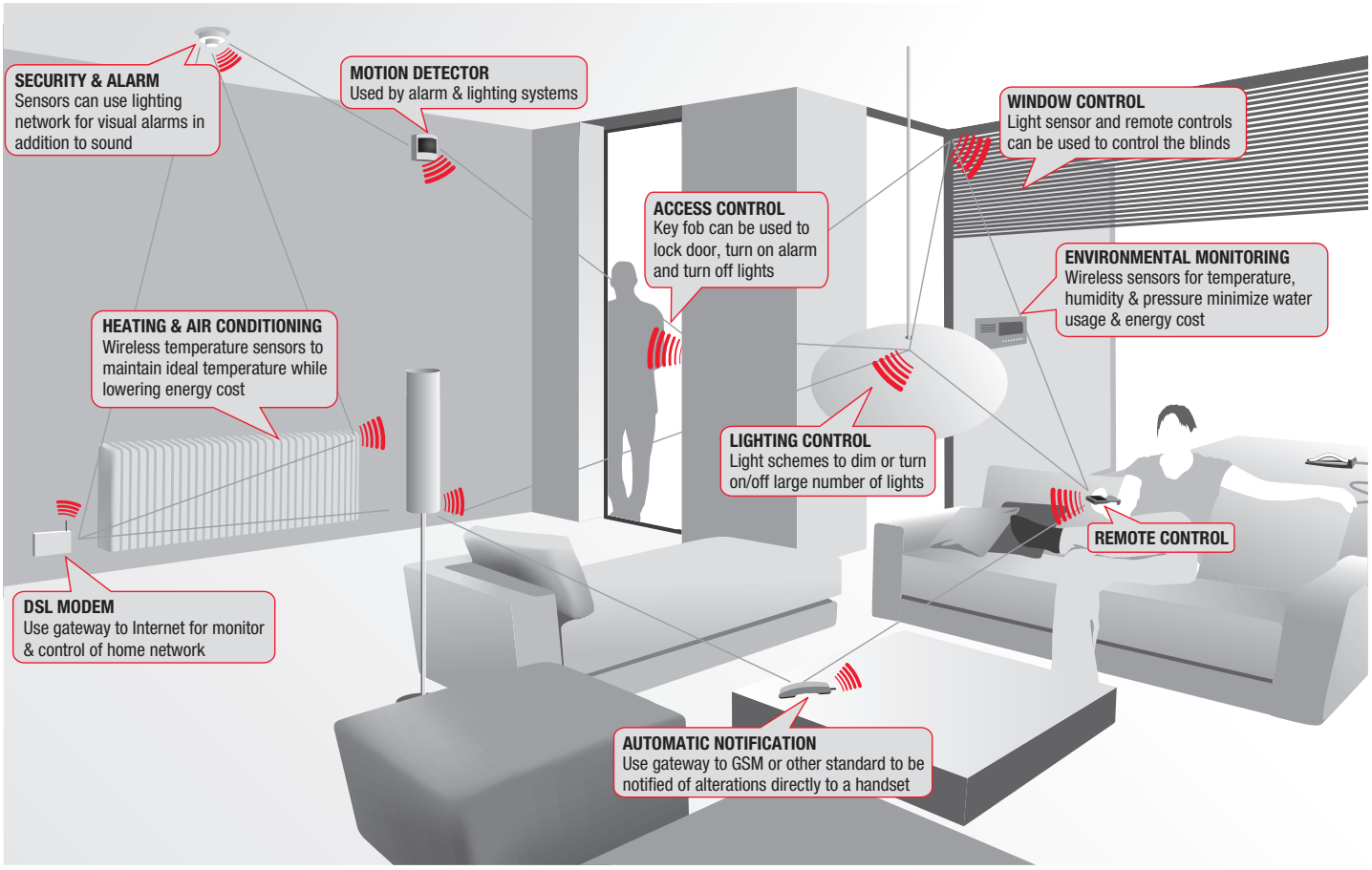
- Golden Unit ZigBee PRO software stack: deployed in millions of systems worldwide today
- Over The Air (OTA) feature allows future updates for your deployed hardware
- A broad range of certified sample applications reduce your development costs
- Flexible architecture choices

Application areas

ZigBee 802.15.4 can be used in any monitoring and control application that requires a wireless link:

- Commercial and residential lighting
- Home, building and industrial automation
- Energy harvesting
- Home control/security
- Medical/patient monitoring
- Logistics and asset tracking
- Sensor networks and active RFID
- Advanced metering/smart energy
- Commercial building automation

www.ti.com/z-stack



6LoWPAN Overview

6LoWPAN

6LoWPAN is an open standard defined by IETF (Internet Engineering Task Force) in RFC 4944. It defines IPv6 over low power, low cost RF networks. The 6LoWPAN technology natively supports IPv6 addresses on all nodes in a LoWPAN. 6LoWPAN uses mesh technique to support large scalable networks that require IP connectivity. In case one route fails, the technology allows nodes (routers) to find new routes throughout the network, making 6LoWPAN a robust wireless solution. Like in a ZigBee® environment information is routed even if a node is out of order. 6LoWPAN makes the wireless embedded Internet possible! 6LoWPAN can be used with several different PHY layers, both sub-1 GHz and 2.4 GHz. It runs on top of IEEE 802.15.4 and enables end-to-end IPv6 addressing and IP context.

Application areas

- Outdoor lighting systems
- The focus markets and applications are larger scale networks that require connection to an IP backbone network.
- The most relevant cases are, but not limited to:
  - Smart metering
  - Home, building and industrial automation
  - Industrial automation/monitoring/ process control
  - Logistics and asset tracking
  - Security large scale/commercial

TI's 6LoWPAN solutions

TI's 6LoWPAN solutions are based on hardware from TI and software from its third party Sensinode Ltd. Sensinode Ltd. is a leading supplier of 6LoWPAN software components. TI's 6LoWPAN solutions include:

- Complete hardware and software 6LoWPAN platforms
- High-performance radio, based on the CC1101 radio design or CC1110 and CC430 System-on-Chip (SoC) solutions
- Application support
- Development kits and tools

TI offers two 6LoWPAN platforms, built on the CC1180 and CC430 radios. Both platforms are for sub-1-GHz operation.

- The CC430 SoC is a device that is targeted for low power applications and small form factor designs. The CC430 SoC runs both the 6LoWPAN stack and the customer application on networks up to 50 nodes
- The CC1180 can be used as a wireless network processor. Containing the 6LoWPAN stack, the CC1180 communicates to the system's main processor through the UART interface. This partitioning option allows the designer to keep the application on the main processor
- The CC1101/MSP430 platform is a two-chip solution for larger node applications. The memory size of the MSP430F5xx family provides more partitioning for both the stack and application profile.

CC1180

Sub-1-GHz 6LoWPAN Network Processor
CC1180RSPR/CC1180RSPT

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1180**

The CC1180 is a cost effective, low power, sub-1-GHz network processor that provides wireless 6LoWPAN functionality for system designers that want to connect their end products to the Internet using standards based IPV6 technology. The CC1180 is a preloaded version of the CC1110F32 SOC, where the TI third party Sensinode's 6LoWPAN stack. Nanostack 2.0 Light runs on the CC1180 Network processor. The application controlling the network processor runs on an external host microcontroller. The CC1180 network processor handles all the timing critical and processing intensive 6LoWPAN protocol tasks and leaves the application microcontroller free to handle.

CC-6LoWPAN-DK-868 Development Kit.

Key features

- Easy Integration of 6LoWPAN with mesh support into any design
- Compact stack (around 20k) optimized for sensor applications
- UART interface to almost any microcontroller running the application
- Standard IP socket programming: Supports updating of the NanoStack 2.0 Lite 6LOWPAN stack using Sensinode NanoBoot API

Benefits

- Integrated hardware design shortens time to market by 25%
- Embedded stack with simple sample applications reduce firmware development by up to 50%
- Compact radio reference design makes it ideal for small form factor end devices and sensors
- Low current consumption optimized for sleeping end nodes and battery operated devices

Applications

- Home and building automation
- Industrial monitoring and control
- Sensor networks
- Medical telehealth

Development tools and software

- CC-6LOWPAN-DK-868
- RF tester application: Eases FCC/ETSI testing

General Characteristics

Parameter	Min	Typ	Max	Unit
Device type	SoC	—	—	—
Frequency ranges min	300	391	782	MHz
Frequency ranges max	348	464	928	MHz
Operating voltage	2.0	—	3.6	V
Operating temperature	–40	—	85	°C
Output power	–30	—	10	dBm
Receiver sensitivity	—	–98	–112	dBm
Standby current	—	0.3	—	µa
Wake up timer (PD->RX/TX)	—	330	—	µS
Modulation techniques	—	GFSK	—	—

Bluetooth® Overview

Bluetooth

Bluetooth wireless technology is one of the most prominent short-range communications technologies with an installed base of more than three billion units. *Bluetooth* is intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security, low power and low cost. A fundamental strength of *Bluetooth* is the ability to simultaneously handle data and voice transmissions. *Bluetooth* is designed to have very low power consumption by allowing radios to be powered down when inactive. The *Bluetooth* specification defines a uniform structure with global acceptance to ensure interoperability of any *Bluetooth*-enabled device.

Application areas

- Internet of Things (IoT)
- Sports and fitness
- Assisted living
- Industrial sensors
- Toys
- Entertainment devices
- Mobile accessories
- All *Bluetooth* wireless applications

How does *Bluetooth* technology work?

Bluetooth technology operates in the unlicensed industrial, scientific and medical (ISM) band at 2.4 to 2.485 GHz, which is available and unlicensed in most countries. *Bluetooth* uses a spread spectrum, frequency hopping, full-duplex signal which was designed to reduce interference between wireless technologies sharing the 2.4-GHz spectrum. *Bluetooth* technology provides greater performance even when other technologies are being used along with *Bluetooth* technology. Information above cited from the *Bluetooth* SIG. For more information on *Bluetooth* technology, visit *www.Bluetooth.com.*

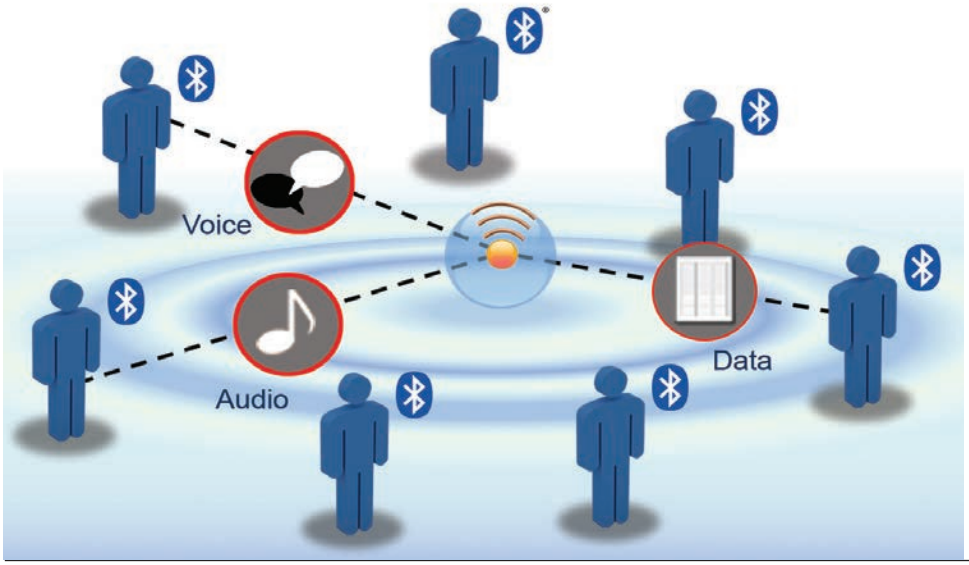
Why TI *Bluetooth*?

TI is one of the leading semiconductor companies providing *Bluetooth* wireless technology for portable, battery-powered devices leveraging nearly a decade of experience and seven generations of products which are optimized for the needs of handheld products. TI is also the market leader in combined wireless products such as the WiLink™ 8 solution single-chip Wi-Fi®/*Bluetooth*/*Bluetooth* low energy device), CC2560 (*Bluetooth*), CC2564 (*Bluetooth*/*Bluetooth* low energy), which further solve issues such as coexistence, antenna sharing in size-constrained devices, cost and power consumption.

Dual mode

Dual-mode *Bluetooth* low energy technology is available as a part of TI's proven WiLink connectivity combo solutions. These solutions support Wi-Fi and dual-mode operations by providing classic *Bluetooth* technology capability along with *Bluetooth* low energy technology. The WiLink 8 module solution includes on-chip coexistence, which yields size, cost, performance and power advantages that ease customer development cycles. WiLink brings connectivity features to mainstream products such as smart phones, mobile Internet devices (MIDs), portable media players (PMPs), gaming devices and personal navigation devices (PNDs).

For longer range, higher throughput and ability to connect to any mobile phone or tablet on the market, TI also has a *Bluetooth* dual-mode solution, the CC2564. It is used for audio and data applications and supports *Bluetooth* and *Bluetooth* low energy, assisted audio (SBC encode/decode) or ANT™ running simultaneously.



SimpleLink™ Bluetooth CC256x Devices

Dual-mode *Bluetooth* 4.1 controller available in certified modules with integrated audio capabilities

CC2560, CC2564

Learn more at: **www.ti.com/bluetooth**

Overview

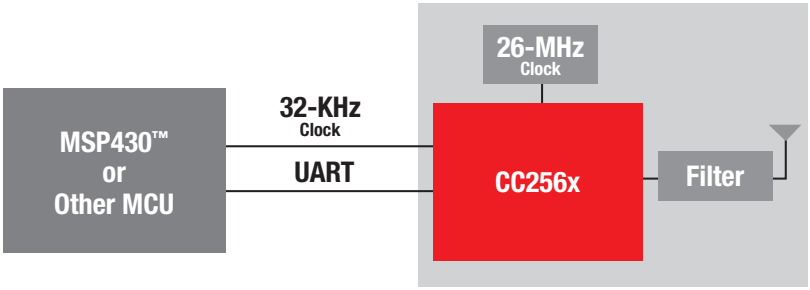
TI SimpleLink CC256x solutions are complete *Bluetooth*® BR/EDR/LE HCI or *Bluetooth* + *Bluetooth* Low Energy solutions that reduce design effort and enable fast time to market.

A royalty-free software *Bluetooth* stack available from TI is pre-integrated with TI's MSP430™ and ARM® Cortex®-M4 MCUs. The stack is also available for MFi solutions and on other MCUs. Examples of profiles supported today include: serial port profile (SPP), human interface device (HID), A2DP (Advanced Audio Distribution Profile), AVRCP (Audio/Video Remote Control Profile) and several BLE profiles (profiles can vary based on the supported MCU).

In addition to software, reference designs are available with a low BOM cost. For example, TI's Audio Sink solution uses the *Bluetooth* device for audio processing, an MSP430, audio DAC and USB charger. TI's Audio Source solution is also available. For more information, visit *TI Designs*.

Benefits

- Best-in-class link budget extends application range
- Simplified hardware and software development
- Reduced development time and costs
- Enables simultaneous operations of *Bluetooth* with *Bluetooth* low energy



SimpleLink CC256x block diagram

SimpleLink™ CC256x Products

Device	Description	Technology supported			Assisted modes	
		BR/EDR	LE	Ant™	HFP 1.6 (WBS)	A2DP
CC2560	*Bluetooth* 4.1 (with EDR)	•			•	•
CC2564*	*Bluetooth* 4.1 + BLE	•	•		•	•
	Bluetooth 4.1 + ANT	•		•	•	•

** The device does not support simultaneous operation of LE, ANT or assisted modes. Any of these modes can run simultaneous to Bluetooth BR/EDR.*

Applications

- Cable replacement
- Smart watches, activity trackers
- Mobile device accessories
- Industrial control
- Audio streaming solutions
- Point of sale

SimpleLink *Bluetooth* CC256x resources

- Learn more: *www.ti.com/bluetooth*
- E2E™ Forum: *www.ti.com/wiconforum*
- CC256x Wiki: *www.ti.com/cc2564wiki*

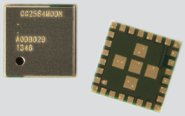
Continued on following page.

SimpleLink™ Bluetooth CC256x Devices (continued)

Dual-mode *Bluetooth* 4.1 controller available in certified modules with integrated audio capabilities
CC2560, CC2564

Learn more at: **www.ti.com/bluetooth**

Development Tools and Software

Product Number	Description	Availability
SimpleLink CC256x modules from TI 	TI-certified modules based on the CC2564 devices	Available through TI and TI authorized distributors
SimpleLink CC2564MODEM	CC2564 Module Evaluation board Intended for evaluation purposes of the CC2564 module. Works with processor platforms such as TI's ultra-low-power MSP430™ and the performance TM4C ARM® Cortex®-MF microcontrollers.	TI Store and authorized distributors
***Bluetooth* and MSP430 Audio Sink Reference Design**	Enables *Bluetooth* audio (SBC encode/decode) with CC2560 and the ultra-low power MSP430F5229 and digital input speaker amplifier (TAS2505) and USB charge management device (BQ24055). Reference design is a cost-effective audio implementation, with full design files provided for application and end product development. Software supported includes Stonestreet One Bluetopia *Bluetooth* stack (certified and royalty free)	*Download at TI Designs* Boards are orderable through TI Store
***Bluetooth* and MSP430 Audio Source Reference Design**	Enables *Bluetooth* audio (SBC encode/decode) with CC2560 and the ultra-low power MSP430F5229 and digital DAC plus USB charge management device (BQ24055). Reference design is a cost-effective audio implementation, with full design files provided for application and end product development. Software supported includes Stonestreet One Bluetopia *Bluetooth* stack (certified and royalty free).	*Download at TI Designs* Coming soon: Boards will be orderable through TI Store
SimpleLink CC256x BoosterPack	SimpleLink *Bluetooth* BoosterPack evaluation kit has flexibility to work with ultra-low power microcontrollers such as the TI MSP430 and TM4C Series LaunchPad evaluation kits	Coming soon: Boards will be orderable through TI Store
CC256xQFNEM	CC256x *Bluetooth*® / dual-mode QFN device evaluation module	TI Store and authorized distributors

Bluetooth Low Energy Overview

Bluetooth® low energy technology

Bluetooth low energy technology offers ultra-low power, state-of-the-art communication capabilities for consumer medical, mobile accessories, sports and wellness applications. Compared to classic *Bluetooth* capabilities, *Bluetooth* low energy is a connectionless protocol, which significantly reduces the amount of time the radio must be on. Requiring only a fraction of the power consumption of traditional *Bluetooth* technology, *Bluetooth* low energy can enable target applications to operate on a coin cell for more than a year.

Application areas

- Mobile accessories
- Consumer health/medical
- Health and fitness
- Remote controls
- Wireless sensor systems

TI's *Bluetooth* low energy solutions – single mode and dual mode

TI provides *Bluetooth* low energy single-mode solutions for sensor applications and dual-mode solutions for mobile handheld devices. With both sides of the link, TI delivers a fully tested and robust *Bluetooth* low energy ecosystem. TI also offers Dual mode Smart Ready solutions based on CC2564. This dual mode solution allows customers to create solutions that talk with both classic Bluetooth devices and *Bluetooth* low energy devices. TI's *Bluetooth* low energy solutions include:

- TI provides both single mode and dual-mode *Bluetooth* low energy solutions
- Both sides of the link to create a fully tested *Bluetooth* low energy ecosystem – from smart sensors to smart phones
- Leading RF performance up to –97dBm
- Excellent coexistence with other 2.4-GHz devices

- CC2540 System on a chip integrated solution (host and controller) and certified modules available

Single mode

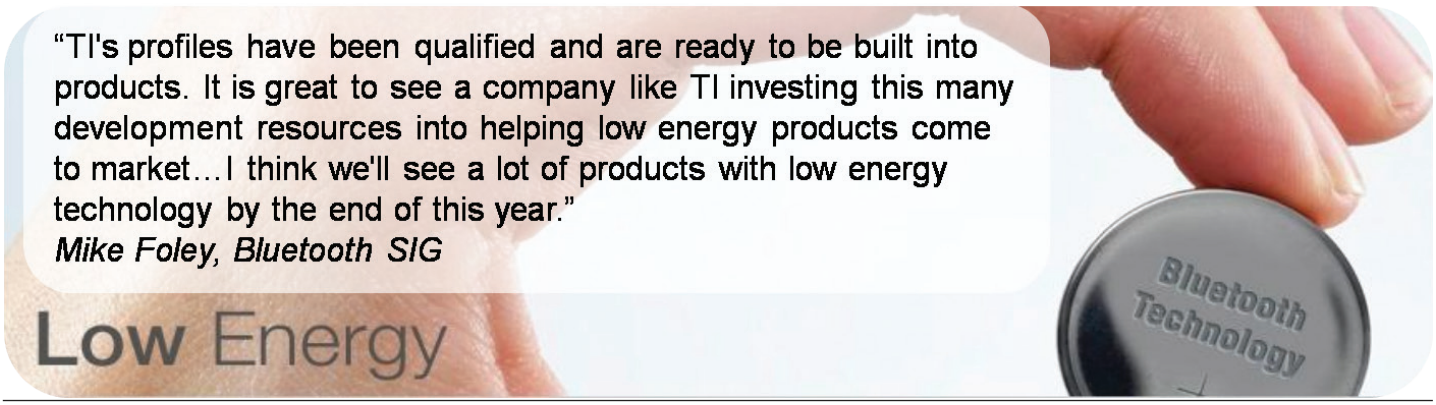
TI's *Bluetooth* low energy solution for sensor applications includes the CC254x 2.4-GHz system-on-chip (SoC), TI protocol stack, profile software and application support. The CC254x is an ultra-low power, true one-chip integrated solution with controller, host and application on one device. It is a Flash-based and flexible device, with ultra-low power consumption, leading RF performance and excellent coexistence with other 2.4-GHz devices. Combined with the *Bluetooth* low energy protocol stack, the CC254x forms the market's most flexible and cost-effective single-mode *Bluetooth* low energy solution.

For more information see page 20.

www.ti.com/bluetoothlowenergy

Bluetooth low energy for personal connectivity and health and fitness applications

"TI's profiles have been qualified and are ready to be built into products. It is great to see a company like TI investing this many development resources into helping low energy products come to market…I think we'll see a lot of products with low energy technology by the end of this year."
Mike Foley, Bluetooth SIG



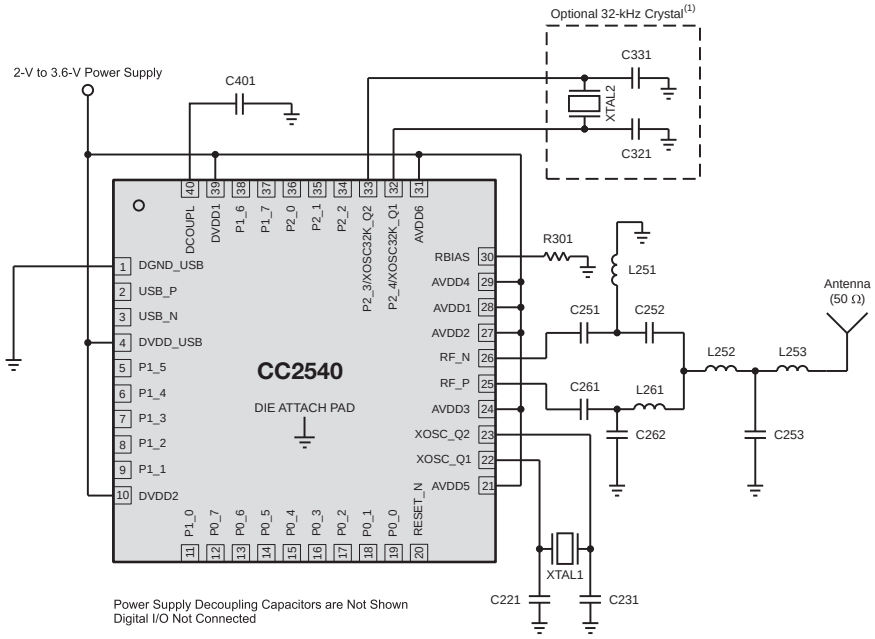
CC2540

Single-Mode *Bluetooth*® Low Energy System-on-Chip
CC2540

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC2540**

See also: **www.ti.com/product/tps62730**

The CC2540 is a cost-effective, low-power, true System-on-Chip (SoC) solution for single-mode *Bluetooth* low energy applications, including mobile accessories, sports and fitness, consumer health, sensors and actuators, remote controls, HID, proximity, and more. The CC2540 combines a 1-Mbps GFSK RF transceiver, offering superior range over the competition with a peripheral rich 8051 MCU core. This highly integrated and low cost SoC, coupled with TI's *Bluetooth* low energy stack, offers a true one-chip integrated solution.



CC2540 application circuit.

Key features

- True one-chip single-mode *Bluetooth* low energy solution
- Optimized RF performance including Tx/Rx power and selectivity
- Extensive peripheral set including USB, DMA, GPIO, USARTs, ADC, timers
- Flexible low power modes to maximize system lifetime when battery powered

Benefits

- Versatile feature-rich device allows lowest cost system when integrating application and stack on single chip
- RF performance maximizes communication range while simultaneously minimizing the effect of interference sources
- Supports range of applications and reduces BOM cost through all-in-one SoC solution
- Ultra-low average-power consumption in low-duty cycle systems

Applications

- Mobile/laptop accessories
- Sports and fitness
- Consumer health and medical
- Proximity

Development tools and software

- Single-mode *Bluetooth* low energy-compliant software stack
- CC2540DK-MINI Development Kit for quick product development
- *Bluetooth* low energy packet sniffer
- Application profiles, sample applications, documentation and more

General Characteristics

Parameter	Min	Typ	Max	Unit
Frequency range	2402		2480	MHz
Data rate	—	1000	—	kBaud
Operating voltage	2	—	3.6	V
Operating temperature	–40	—	85	°C
Output power	–20	—	4	dBm
RX mode				
Receiver sensitivity	—	–93	—	dBm
Adjacent channel rejection, +1 MHz	—	5	—	dB
Adjacent channel rejection, –1 MHz	—	5	—	dB
Alternate channel rejection, +2 MHz	—	30	—	dB
Alternate channel rejection, –2 MHz	—	30	—	dB
Current consumption				
Current consumption, RX	—	19.6	—	mA
Current consumption, TX, +4 dBm	—	31.6	—	mA
Current consumption, TX, 0 dBm	—	27	—	mA
Current consumption, power down	—	0.4	—	µA

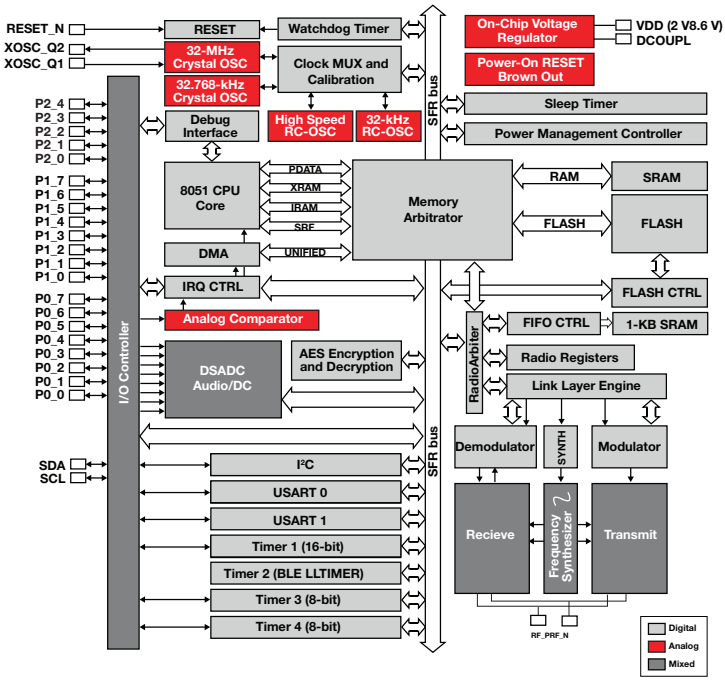
CC2541

Single-Mode *Bluetooth*® Low Energy System-on-Chip
CC2541

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC2541**

The CC2541 is a power-optimized true system-on-chip (SoC) solution for both low energy and proprietary 2.4-GHz applications. It enables robust network nodes to be built with low total bill-of-material costs. The CC2541 combines the excellent performance of a leading RF transceiver with an industry-standard enhanced 8051 MCU, in-system programmable Flash memory, 8-KB RAM, and many other powerful supporting features and peripherals. The CC2541 is highly suited for systems where ultra-low power consumption is required. This is specified by various operating modes. Short transition times between operating modes further enable low power consumption.

The CC2541 is pin-compatible with the CC2540 in the 6-mm × 6-mm QFN-40 package, if the USB is not used on the CC2540 and the I2C/extra I/O is not used on the CC2541.



Key features

- True one-chip single mode *Bluetooth* low energy solution
- Optimized RF performance including Tx/Rx power and selectivity
- Extensive peripheral set including I²C, DMA, GPIO, USARTs, ADC, timers
- Flexible low power modes to maximize system lifetime when battery powered

Benefits

- Versatile feature-rich device allows lowest cost system when integrating application and stack on single chip
- RF performance maximizes communication range while simultaneously minimizing the effect of interference sources
- Supports range of applications and reduces BOM cost through all-in-one SoC solution
- Ultra low average-power consumption in low-duty cycle systems

Applications

- Mobile/laptop accessories
- Sports and fitness
- Consumer health and medical
- Proximity

Development tools and software

- Single-mode *Bluetooth* low energy compliant software stack
- CC2541EMK Evaluation Module Kit for quick product development
- CC2541DK-MINI Development Kit for quick product development
- CC2540DK Development Kit for advance prototyping
- *Bluetooth* low energy packet sniffer
- Application profiles, sample applications, documentation and more

General Characteristics

Parameter	Min	Typ	Max	Unit
Frequency range	2402		2480	MHz
Data rate	—	1000	—	kBaud
Operating voltage	2	—	3.6	V
Operating temperature	–40	—	85	°C
Output power	–20	—	0	dBm
RX mode				
Receiver sensitivity	—	–93	—	dBm
Current consumption				
Current consumption, RX	—	17.9	—	mA
Current consumption, TX, 0 dBm	—	18.2	—	mA
Current consumption, power down	—	0.4	—	µA

BLEStack – Bluetooth Low Energy Protocol Stack and Tools

TI's *Bluetooth*® low energy (BLE) software development kit includes all necessary software to get started on the development of single-mode *Bluetooth* low energy applications using the CC2540/CC2541 system-on-chip. It includes object code with the *Bluetooth* low energy protocol stack, a sample project and applications with source code, and BTool, a Windows PC application for testing *Bluetooth* low energy applications. In addition to the software, the kit contains documentation, including a developer's guide and *Bluetooth* low energy API guide.

Key features

- *Bluetooth* specification version 4.0 compliant, single mode low energy host and controller sub-system. Stack certified as controller and host sub-systems.
- TI's *Bluetooth* low energy solution includes System-on-Chip (SoC), in-house developed protocol stack, profile software and application support
- Profile support planned based on specific profile specifications (attribute, PUID, proximity, remote and more)
- Both master and slave role support, multi-role support
- Sample applications for profile and proprietary products
- Optimized specifically for CC2540/CC2541
- Available to all CC2540/CC2541 customers as object code (libraries)
- Royalty-free protocol stack
- Leverages TI's long experience in low-power radio protocol stacks for ZigBee®, RF4CE and SimpliciTI™

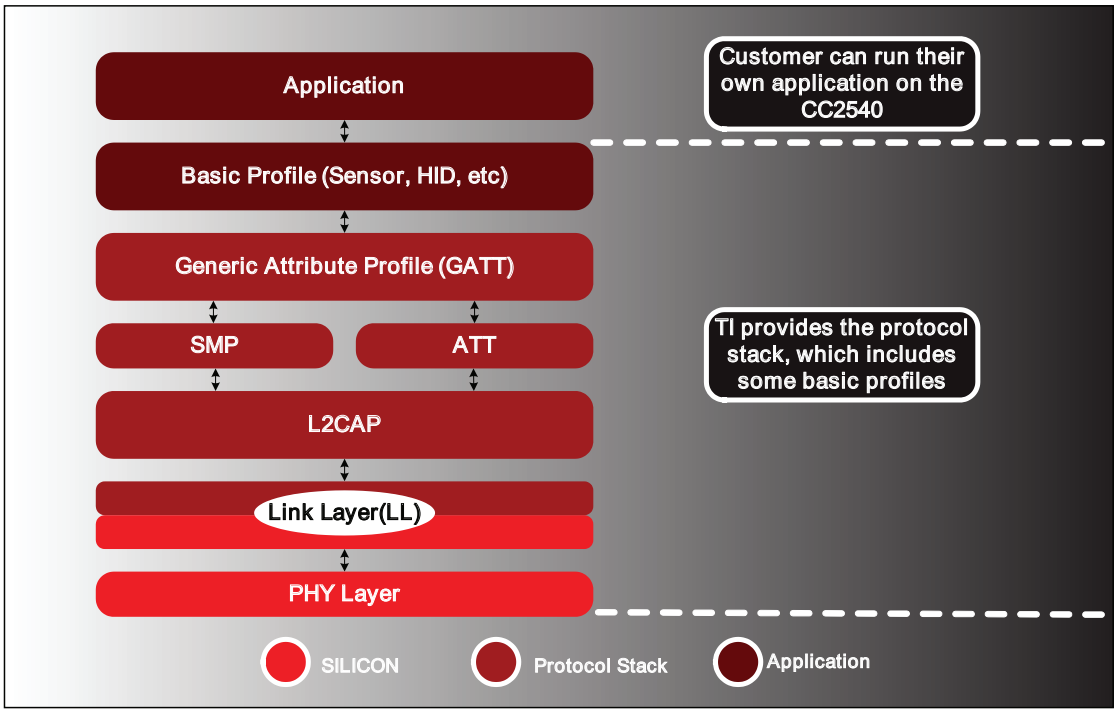
Benefits

- Easy development and certification of *Bluetooth* low energy end products
- Low power consumption
- Small stack footprint
- Robust and flexible stack implementation
- All aspects of *Bluetooth* low energy development provided by TI

Application areas

- Mobile phone accessories
- Sports/leisure/medical equipment
- Gaming/HID/remote controls
- Proximity applications – security or other spatially aware applications

www.ti.com/blestack



ANT™ Overview

What is ANT?

ANT provides a simple, low-cost and ultra-low power solution for short-range wireless communication in point-to-point and more complex network topologies. Suitable for various applications, ANT is today a proven and established technology for collection, automatic transfer and tracking of sensor data within sports, wellness management and home health monitoring applications.

Application areas

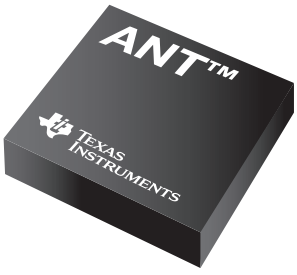
- Sports/Fitness
- Consumer health/medical
- Mobile accessories
- Wireless sensor systems

TI's ANT solutions– from smart sensors to smart phones

TI's ANT products feature full system solutions for both sensor applications and mobile handheld devices. With both sides of the ANT link, TI delivers fully tested and robust ANT ecosystem solutions – from smart sensors to smart phones. TI's ANT solutions are developed in cooperation with Dynastream Innovations Inc, the company behind ANT. TI's ANT solutions include:

- Only TI offers single-mode (CC2570/71) and dual-mode solutions (CC2567, WiLink)
- Fully tested TI ANT ecosystem solution – for both sensor and mobile handheld devices
- Best-in-class RF performance
- Excellent coexistence with other 2.4-GHz devices

www.thisisant.com



www.ti.com/ant

CC257x ANT network processor + MSP430™ MCU

TI's ANT sensor device is a dual-chip solution, combining market leading RF technology and the MSP430, the world's lowest power microcontroller. The CC257x network processors are 2.4-GHz devices tailored for ANT sensor applications. The ICs are easy to integrate, low cost, with ultra-low power consumption and superior RF performance, making them versatile enough to support a wide range of applications. In cooperation with Dynastream Innovations Inc, TI delivers a full turnkey ANT sensor solution, including software and application support.

For more information see 24.

CC2564 dual-mode ANT and *Bluetooth*

The CC2564 is the first dual-mode, ANT and *Bluetooth* solution in the market. This solution allows customers to connect to mobile phones and computers over *Bluetooth* from ANT+ enabled devices, and allows customers with *Bluetooth* solutions to add ultra low-power ANT+ connectivity.

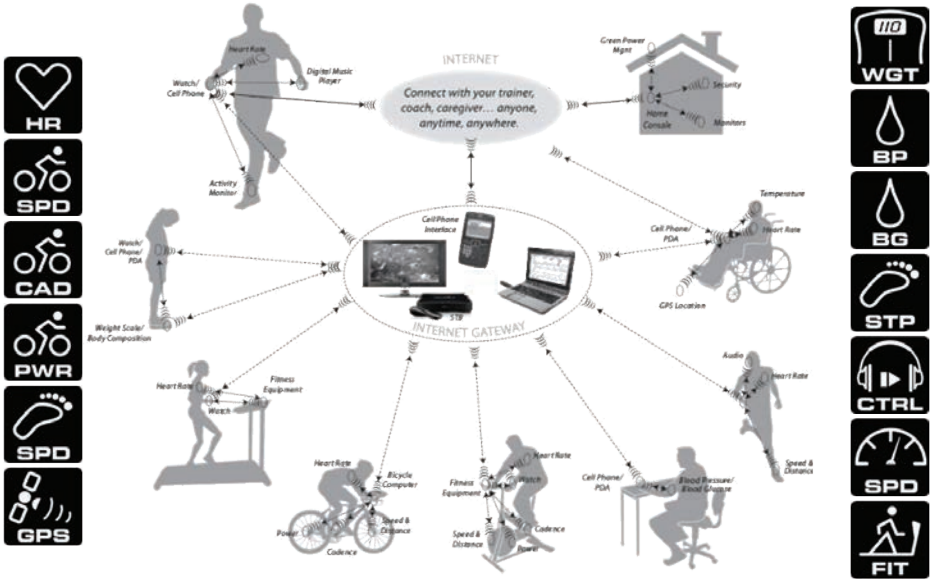
The CC2567-PAN1327/17 is provided as a module to help customers reduce development time, lower manufacturing costs, save board space, ease certification, and minimize RF expertise required.

For more information see page 17.

ANT+ smartphone connectivity

The functionality of ANT enables mobile handheld device manufacturers to deliver ANT+ interoperable sports, fitness and consumer health monitoring products. TI's WiLink™ family is the first to deliver ANT+ communication on a connectivity combo solution. Leveraging TI's connectivity leadership in the Smartphone market, the ANT+ ecosystem is expanding its reach into the mobile handheld device market. WiLink is the industry's first true single-chip mobile WLAN, GPS, *Bluetooth*®, *Bluetooth* low energy, ANT and FM transmit/receive solution. WiLink brings connectivity features to mainstream products such as smartphones, mobile Internet devices (MIDs) and portable media players (PMPs). Existing devices based on both WiLink and BlueLink™ solutions can enable ANT with a simple software upgrade, to connect to the many available ANT+ sensors today. For more information visit

www.ti.com/wilink



CC2570/CC2571

ANT™ Network Processor
CC2570/CC2571

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC2570**

The CC2570 and CC2571 are ANT RF network processors that implement the easy-to-use, power-efficient ANT protocol. The CC2570 supports 1 ANT channel, while the CC2571 supports 8 ANT channels. The CC2570/71 can be connected to a host MCU (such as an MSP430™) through a UART or SPI serial interface and accessed through a set of API calls. The majority of the ANT protocol is built into the CC2570/71, including the ANT-FS file system functionality; only the application and profile layers need to reside on the host MCU, thus keeping host MCU memory requirements to a minimum.

Key features

- ANT compliant RF network processors
- UART/SPI serial interface to easy-to-use API command set
- Excellent RF performance (avg. power and boosted output power)
- Accurate full-range RSSI function suited for proximity
- ANT-FS support

Benefits

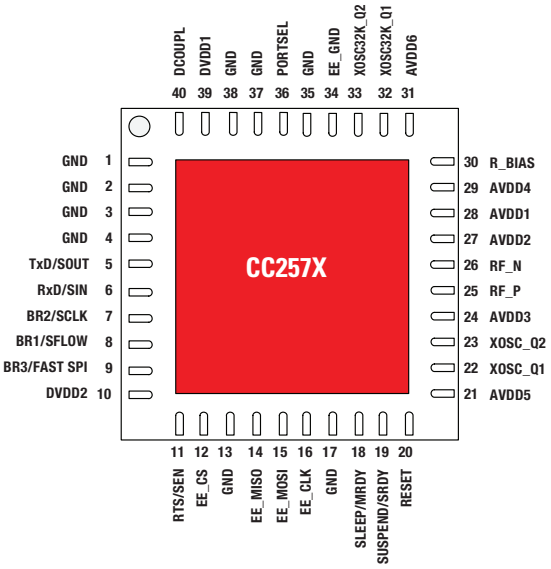
- Easy-to-integrate into ANT products
- Simple, accessible serial interface to ANT-enable your product
- Optimized low power for long device lifetime
- High resolution RSSI proximity pairing

Applications

- Sports and fitness equipment
- Health and medical equipment
- Consumer health devices
- Consumer electronics
- Wireless sensor networks

Development tools and software

- ANTC7EK1 CC257x Development Kit
- ANTware
- Integrated ANT-FS reference design
- ANT-FS PC host
- Embedded reference design



CC2570 package.

General Characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2400		2507	MHz
Data rate	—		—	kBaud
Operating voltage	2.0	—	3.6	V
Operating temperature	–40	—	85	°C
Output power	–20	—	4	dBm
RX mode				
Receiver sensitivity	—	–85.8	—	dBm
Adjacent channel rejection, +2 MHz	—	23	—	dB
Adjacent channel rejection, –2 MHz	—	23	—	dB
Alternate channel rejection, +4 MHz	—	39	—	dB
Alternate channel rejection, –4 MHz	—	39	—	dB
Current consumption				
Current consumption, RX	—	23.7	—	mA
Current consumption, TX, +4 dBm	—	34.3	—	mA
Current consumption, TX, 0 dBm	—	28.8	—	mA
Current consumption, power down	—	<1	—	µA

ZigBee® RF4CE Overview

With the use of ZigBee® RF4CE radio frequency (RF) technology, remote control applications can operate non-line-of-sight and provide more advanced features based on bidirectional communication.

ZigBee RF4CE advanced features for remote control applications:

- Non line-of-sight control
- Longer range
- Richer communication
- Increased reliability
- Enhanced features and flexibility
- Interoperability
- Longer battery life

Application areas

- Remote controls
- Set-top boxes, TVs, Blu-Ray players
- 3D glasses

TI's RF4CE solutions include:

- Mature and broad portfolio (third-generation 802.15.4 SoC, RF4CE golden platform)
- Market leading performance (best-in-class adjacent/alternate channel rejection, lowest system power consumption)
- System expertise (HW, SW, tools experts, influential contributor to RF4CE standard)
- WWW support

RemoTI™ is a complete hardware and software solution for RF4CE remote control applications. TI has a mature and broad Portfolio (3rd generation 802.15.4 SoC and RF4CE golden platform):

- Software: The industry-leading RF4CE-compliant stack feature the ZRC profile, a simple API, easy to understand sample application code and remote control reference design.
- Hardware: CC2533 System-on-Chip (SoC) optimized for IEEE 802.15.4-based remote-control applications. The CC2533 enables single-chip remote controls to be built with lower power, higher reliability and lower bill-of material cost than alternative devices.
- Extensive worldwide support and tools to ensure that development of ZigBee RF4CE-based products is simple, fast and can be completed at minimal cost.

TI's industry-leading ZigBee RF4CE protocol stack

TI's ZigBee RF4CE-compliant protocol stack for remote control applications is built on TI's well proven IEEE 802.15.4 compliant TIMAC. It offers a simple, easy-to-use, intuitive software architectural framework and all of the tools, documentation, and support needed to build an RF4CE compliant product.

The stack is compliant with the ZigBee RF4CE specification and supports the ZRC (ZigBee Remote Control) profile and will support the upcoming ZID (ZigBee Input Device) profile.

The latest RemoTI stack is downloadable from the TI web site without any royalty charge.

Key features

- CC2530, CC2531 (USB), and CC2533 RF SoC and CC259x RF front-end support
- Remote control and proprietary profile support
- USB HID class support including keyboard and consumer controls pages
- Simple RemoTI API, or optional direct RF4CE interface
- Complete sample application code
- UART, SPI, keypad, LED and other driver support
- IR generation sample code for CC253x
- Easy-to-use development kits

www.ti.com/rf4ce

CC2533

ZigBee® RF4CE System-on-Chip
CC2533

NEW

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC2533**

The CC2533 is a cost-effective, low power, and true System-on-Chip (SoC) solution specifically tailored to IEEE 802.15.4/RF4CE applications. The CC2533 comes in three different versions: CC2533-F32/64 with 32/64-KB Flash memory and 4 KB of RAM and the CC2533-F96 with 96KB Flash and 6 KB of RAM. The CC2533 combines a fully integrated high-performance RF transceiver with an industry-standard enhanced 8051 MCU and powerful supporting features and peripherals.

Key features

- Up to 96-KB Flash with 20K erase cycles to support over-the-air updates, large applications
- Up to 6-KB RAM for complex remote control applications
- Programmable output power up to +7 dBm
- Less than 1-µA current consumption in power down with sleep timer running
- UART, I^2C and SPI interfaces
- IR generation and modulation engine

Benefits

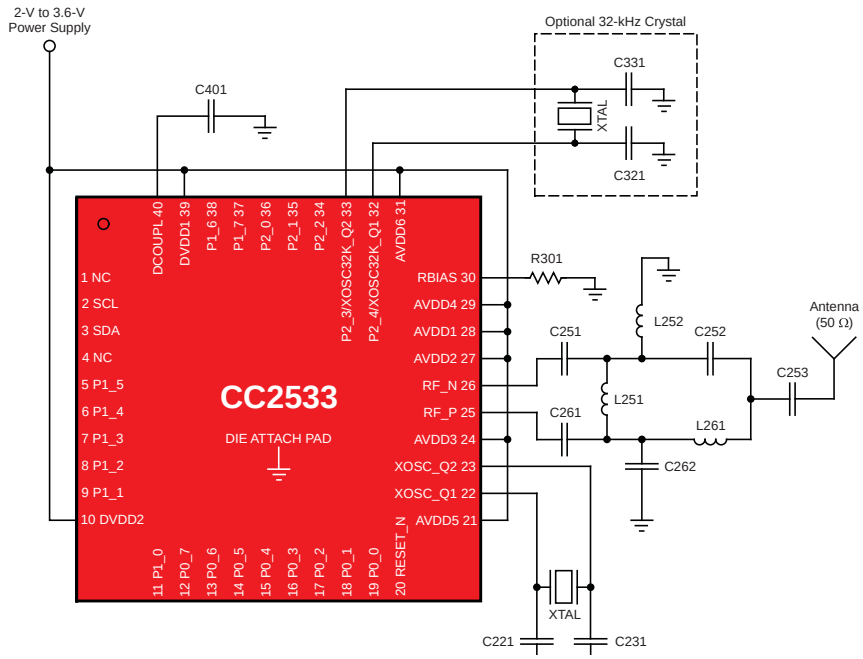
- Supports ZigBee RF4CE and 802.15.4-based solutions
- Excellent receiver sensitivity and programmable output power
- Very-low current consumption in RX, TX, and multiple low-power modes ensure long battery lifetime
- Best-in-class selectivity and blocking performance (50-dB ACR)

Applications

- Remote controls
- Set-top boxes, TVs, Blu-Ray players
- 3D glasses
- Smart Energy

Development tools and software

- REMOTI – RF4CE compliant protocol stack
- CC2533DK-RF4CE-BA – CC2533 RF4CE Development Kit
- CC2533DK – CC2533 Development Kit
- CC2533EMK – CC2533 Evaluation Module Kit



CC2533 application circuit.

General Characteristics

Parameter	Min	Typ	Max	Unit
Operating conditions				
Frequency range	2394	—	2507	MHz
Operating temperature range	–40	—	125	°C
Operating supply voltage	2.0	—	3.6	V
Radio bit rate	—	250	—	kBaud
Receiver sensitivity	—	–97	—	dBm
Adjacent channel rejection	—	49/49	—	dB
Alternate channel rejection	—	57/57	—	dB
Blocking	—	57/57	—	dB
Nominal output power in TX mode	—	+4.5	—	dBm
Current consumption				
MCU active and RX mode	—	25	—	mA
MCU active and TX mode, +4 dBm	—	34	—	mA
Power mode 1	—	200	—	µA
Power mode 2	—	1	—	µA
Power mode 3	—	0.5	—	µA
Wake-up and timing				
From power mode 2 or 3 to active	—	120	—	µs
From active to RX or TX	—	192	—	µs

PurePath™ Wireless Audio Overview

PurePath™ Wireless Audio

By employing proprietary technology called PurePath Wireless, the CC85xx device family provides robust, high-quality, short-range 2.4-GHz wireless digital audio streaming in low-cost, single-chip solutions.

Two or more devices form a PurePath Wireless audio network. Great care has been taken to ensure that this audio network provides gap-less and robust audio streaming in varied environments and that it can coexist with existing wireless technologies in the crowded 2.4-GHz ISM band.

Most applications can be implemented without any software development and only require the CC85xx to be connected to an external audio source or sink (such as an audio codec, S/PDIF interface or class-D amplifier) and a few push buttons, switches or LED for human interaction. Advanced applications can interface a host processor or DSP directly to the CC85xx and directly stream audio and control most aspects of device and audio network operation.

The PurePath Wireless Configurator, a PC-based configuration tool, is used to set up the desired functionality and parameters of the target system and then produces firmware images that subsequently must be programmed into the embedded Flash memory of each CC85xx.

All devices in the CC85xx family interface seamlessly with the CC2590 RF range extender device to allow for even wider RF coverage and improved robustness in difficult environments.

Built-in wireless audio protocol with excellent robustness and coexistence through multiple techniques:

- Adaptive frequency hopping
- Forward error correction
- Buffering and retransmission
- Error concealment
- Optional high-quality audio compression

Digital audio support

- CD-quality uncompressed audio (44.1/48 KHz, 16/24 bits)
- Digital I^2S audio interface supports 1–2 audio channels (CC852x) or 3–4 audio channels (CC853x) at sample rates of 32, 40.275, 44.1 and 48-kHz/16-bit word-widths
- Audio latency less than 20 ms
- Data side-channel allows data to be sent alongside the audio between external host controllers

Application areas

- Wireless headphones/headsets
- Wireless speaker systems
- Wireless signal cable replacement
- Wireless home theatre systems

Wireless headphone/headset design

- Cost-optimized design with 100% TI content
- 2× longer battery life than typical headphone (22hr on 465mah battery)
- Well suited for high-quality headphones/headsets
- Design files available from TI

Wireless 25W Li-ion powered speaker design

- Uses CC8520, TAS5727, BQ24610 (Li-Ion charger), LM2842Y (step-down DC/DC)
- Targets ~20h playback (2 aHr @ CD quality)
- Well suited for PC/portable speakers
- iPhone RC application available (with *Bluetooth* low energy)

CC8520

PurePath™ Wireless 2.4-GHz RF System-on-Chip for Wireless Digital Audio Streaming CC8520

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC8520**

The CC8520 is used to build a lossless wireless audio link. One CC8520 acts as audio source and the other as audio sink. I²S data is taken as input on the audio source side, audio data is transmitted without loss to the audio sink which then outputs the I²S audio data.

Key features

- Embedded audio network protocol with state-of-the art error correction and concealment techniques
- Uncompressed wireless 44.1/48 kHz stereo audio
- Autonomous operation
- Free PurePath Wireless Configurator PC tool

Benefits

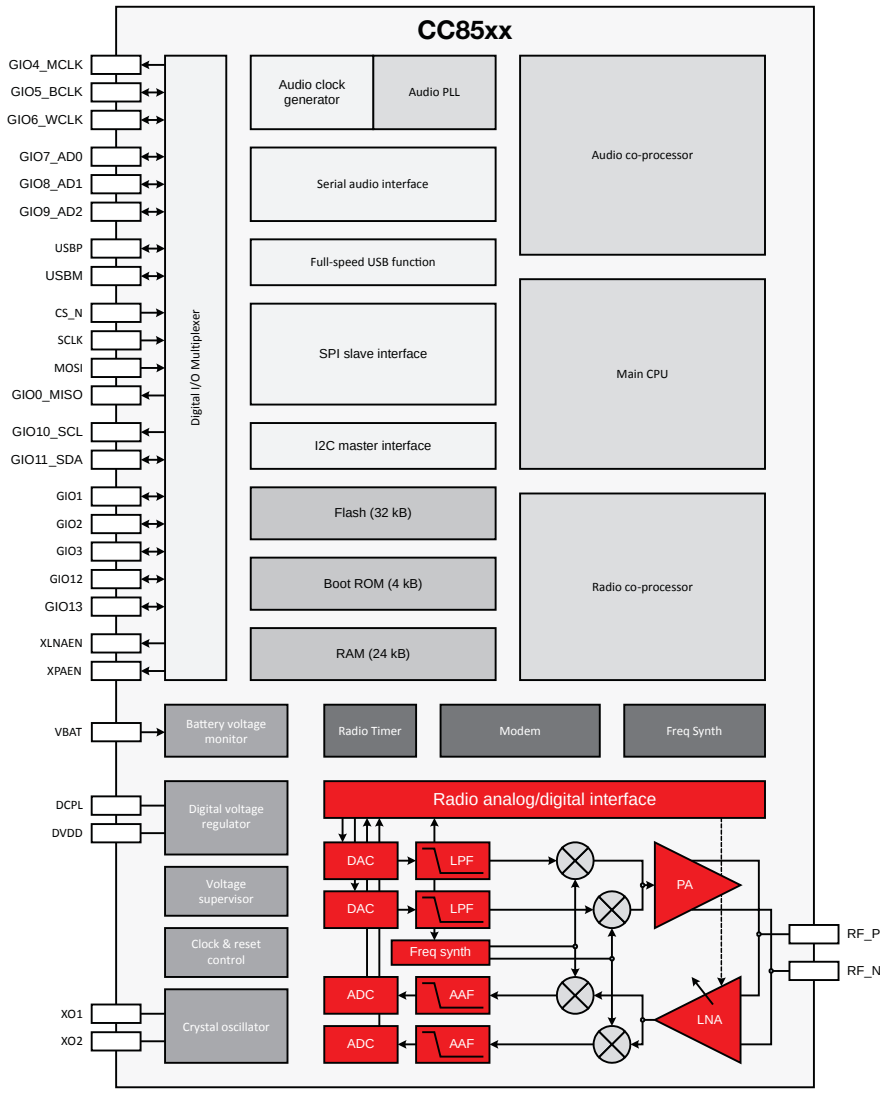
- No dropouts during audio playback
- Well suited for hi-fi audio systems
- No microcontroller or external memory needed
- Fast development time with no software development needed

Applications

- Wireless headphones/headsets
- Wireless speaker systems
- Wireless signal cable replacement
- Wireless home theatre systems

Development tools and software

- CC85XXDK Development Kit
- PurePath wireless configurator PC tool: *www.ti.com/ppwc*
- CC85XXDK-HEADSET and PurePath Wireless Commander *www.ti.com/tool/purepath-wl-cmd*



CC8520 block diagram.

General Characteristics

	CC8520	CC8521	CC8530	CC8531
Number of wireless audio channels	2	2	4	4
Power consumption (RX) (mA)	25	25	25	25
Power consumption (TX) (mA)	29	29	29	29
Standby current (µA)	1	1	1	1
Data rate (max, Mbps)	5	5	5	5
Frequency range	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz
Audio I/O	Digital I²S	USB Full Speed	Digital I²S	USB Full Speed

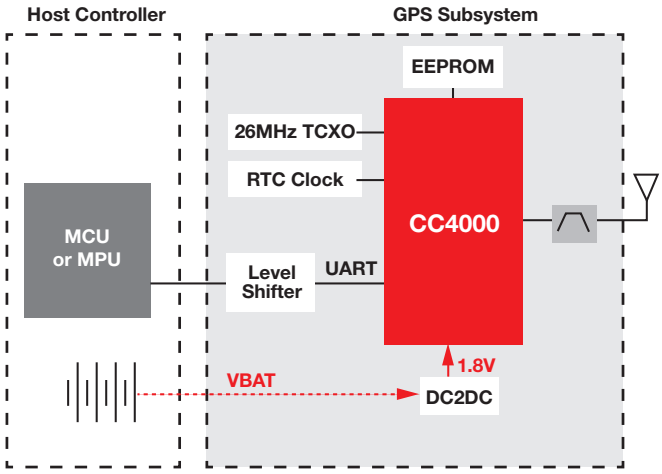
CC4000-TC6000GN

SimpleLink™ GNS GPS Module
CC4000-TC6000GN

Get samples, evaluation modules and application notes at: **www.ti.com/product/cc4000-tc6000gn**

The following product brief applies to the TC6000GN – a highly-integrated GPS module offered by GNS using Texas Instruments' SimpleLink™ GPS CC4000. The GNS TC6000GN module enables applications benefitting from precise time, location, and/or velocity data. This solution provides industry standard NMEA protocol data for accurate time, position, latitude, longitude, satellite status, course and speed. This solution provides industry standard NMEA protocol data for accurate time, position, latitude, longitude, satellite status, course and speed. Autonomous warm start and hot start are enabled by on-board memory, improving start-up performance. A single GPIO is used to initiate a GPS fix (Push-to-fix), activating power management for active and deep sleep modes. Applications requiring high precision timing benefit from an independent programmable PPS generator. Further, the GPS driver and firmware is fully integrated into the module, greatly minimizing loading on the host CPU, and reducing system complexity. This allows GPS functionality to simply integrate with very small MCUs and MPUs. This solution is provided as a module to help customers reduce development time, lower manufacturing costs, save board space, and minimize RF and GPS expertise required.

Key features
- GPS driver and firmware fully integrated into module
- Industry-standard NMEA 0183 interface protocol communication
- Protocol communication NMEA provides
  - Time
  - Position
  - Speed
  - Satellite status
  - Course
- Performance:
  - Autonomous cold start TTFF 35 seconds in open sky signal conditions
  - Autonomous hot start TTFF ~ 1 second in open sky signal conditions
  - Tracking accuracy better than 3 meters



CC4000-TC6000GN GPS system diagram.

- GPS tracking sensitivity of –162 dBm
- Push-to-fix: Single GPIO activates power management for active and deep-sleep modes
- Pulse-per-second (PPS) generator: Independent output for high precision timing applications with accuracy <100ns (nominal)

Benefits
- Fully integrated GPS solution
- Standard NMEA protocol communication
- GPS tracking sensitivity –162dBm
- Very small package
- One single power supply
- Low power consumption
- Integrated LNA and TCXO

Applications
- Asset tracking
- Industrial M2M
- Portable navigation
- Fitness / health / medical
- Precision timing

Development tools and software
- CC4000GPSEM module and board
- Sample software for MSP-EXP430FR5529 Development Platform

www.ti.com/tool/cc4000gpsem

General Characteristics

	CC4000	Unit
Receiver Frequency	1575.42	MHz
Operating voltage	1.7 to 1.95	V
I/O operating voltage	1.65 to 1.92	V
Operating temperature	–40°C to + 85	°C
Sensitivity	–162 –147 (autonomous) –155 (assisted)	dBm
Current consumption	80µA (sleep), 68mA (acquisition)	
Interfaces	UART	
Internet crystal frequency	26	MHz
Size	10.0 × 9.3 × 2.3	mm^3

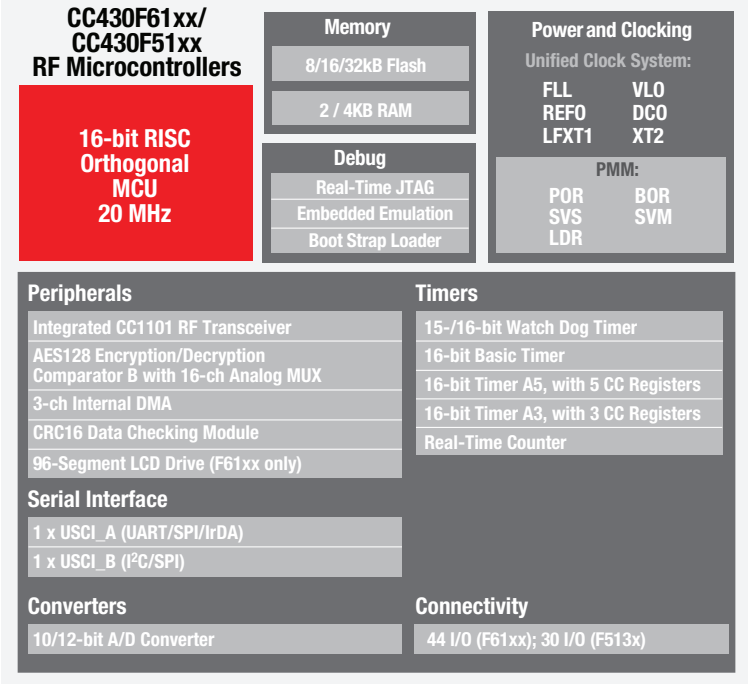
CC430

Integrated RF System-on-Chip Solution (MSP430™ microcontroller+ CC1101 radio)
CC430

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC430**

See also: **www.ti.com/CC430**

The CC430 family of ultra-low-power microcontroller System-on-Chip (SoC), with integrated CC1101 RF transceiver core, consists of several devices featuring different sets of peripherals, targeted for a wide range of applications. The architecture, combined with up to seven low-power modes, is optimized to achieve extended battery life in portable measurement applications. The device features the powerful MSP430™ 16-bit RISC CPU, 16-bit registers, and constant generators that contribute to maximum code efficiency. The CC430 family provides a tight integration between the microcontroller core, its peripherals, software, and the RF transceiver, making these true SoC solutions easy to use as well as improving performance.



CC430 block diagram.

Key features
- Integrates MSP430 MCU and CC1101 RF transceiver
- As low as 1µA current consumption with state retention, 1.7 µA standby current with real time clock (RTC) and 180µA/MHz active current
- AES-128 hardware module
- Code compatibility with existing MSP430 and free RF software available
- 10- and 12-bit A/D converter options

Benefits
- Save space and components in design
- Extended battery life in portable applications
- Secure RF transmissions
- Shorter design time with code re-use

Applications
- Low power RF sensors and energy harvesting monitors
- Home security and automation
- Sports and health monitoring
- Wireless networks targeting IEEE 802.15.4g standard

Development tools and software
- eZ430-Chronos wireless watch development tool
- CC430F5137 and CC430F6137 wireless development tools
- CC430F6147 wireless development tool (with DC-DC converter & LCD)
- Supported by Integrated Development Environments (IDEs) from TI and third parties including Code Composer Studio™ IDE (CCStudio) and IAR Embedded Workbench for MSP430 from IAR Systems.

General Characteristics

	CC430F51xx	CC430F61xx
RF frequency bands	300–348MHz, 387–464MHz, 779–928MHz	300–348MHz, 387–464MHz, 779–928MHz
ADC	Optional 10-bit SAR, or 12-bit SAR	10-bit SAR, 12-bit SAR optional
RAM	2–4KB	2–4KB
Flash	8–32KB	8–32 KB
Pin/package	48VQFN	64VQFN
GPIO	30	44
Peripherals	CC1101 RF Transceiver, 32-bit HW Multi, A/Sync Serial Comm USCI, AES-128 En/Decrypt, CRC16, DMA, RTC, Universal clock	CC1101 RF Transceiver, 32-bit HW Multi, A/Sync Serial Comm USCI, AES-128 En/Decrypt, CRC16, DMA, RTC, Universal clock
LCD segments	NA	96
Interface	1 USCI (UART/IrDA/SPI/I2C)	1 USCI (UART/IrDA/SPI/I2C)
Timers	1 16-bit (3CCR), 1 16-bit (5CCR), 1 Watchdog, 1 RTC	1 16-bit (3CCR), 1 16-bit (5CCR), 1 Watchdog, 1 RTC
Temp sensor	Yes	Yes
Brown out reset	Yes	Yes

CC1100E

Integrated Multi-Channel RF Transceiver
CC1100E

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1100E**

Integrated solution provides low cost and high performance

The CC110E is a highly integrated, multi-channel RF transceiver designed for low-power wireless applications in the 470-MHz and 950-MHz ISM bands.

Key features

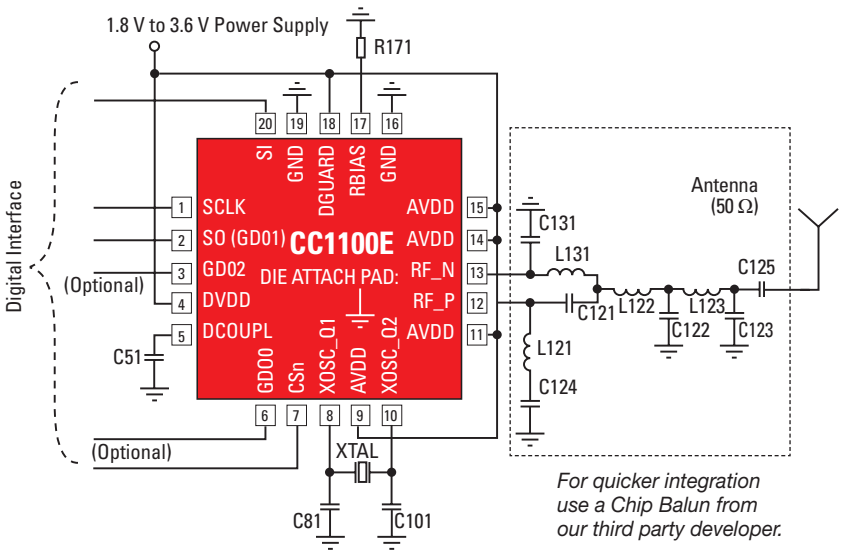
- Sub-1 GHz FSK/GFSK/MSK/ASK/OOK RF Transceiver
- 1.2 to 500-kBaud data rate
- Low-power, low system cost
- Sleep current: –200 nA
- 90-µs PLL lock time: –240 µs from sleep to RX/TX
- On-chip support for sync word detection, address check, flexible packet length and automatic CRC checking
- Separate 64-Byte RX and TX data FIFOs (enable burst mode data transmission)
- Suitable for systems targeting Japanese ARIB STD-T96 and Chinese short range device regulations at 470–510 MHz

Benefits

- Fast development time and low system cost
- Flexible optimization of range power
- Enables use of inexpensive microcontroller
- Enables adaptive channel selection with increased robustness and coexistence of the wireless link
- Small size solution

Applications

- Automatic meter reading
- Active RFID



CC1100E application circuit.

General Characteristics

Parameter					
(433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions:					
Frequency range	470	—	510	MHz	
	950	—	960	MHz	
Operating temperature range	–40	—	+85	°C	
Operating supply voltage	1.8	—	3.6	V	
Data rate (programmable)	1.2	—	500	kBaud	
Output power (programmable)	–30	—	+12	dBm	
Receiver sensitivity, 1.2 kBaud	—	–112	—	dBm	1% packet error rate
Power consumption					
Current consumption RX	—	16	—	mA	Input well above sensitivity limit
Current consumption TX	— —	15.0 30.0	— —	mA mA	0 dBm 12 dBm
Current consumption, power down	—	<1	—	µA	

CC1101

Integrated Multi-Channel RF Transceiver
CC1101

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1101**
See also: **www.ti.com/product/tps62730**

Integrated solution provides low cost and high performance

The CC1101 is a highly integrated, multi-channel RF transceiver designed for low-power wireless applications in the 315/433/868/915-MHz ISM bands. The CC1101 is an upgrade of the CC1100 transceiver with improvements for spurious response, close-in phase noise, input saturation level, output power ramping and extended frequency range.

Key features

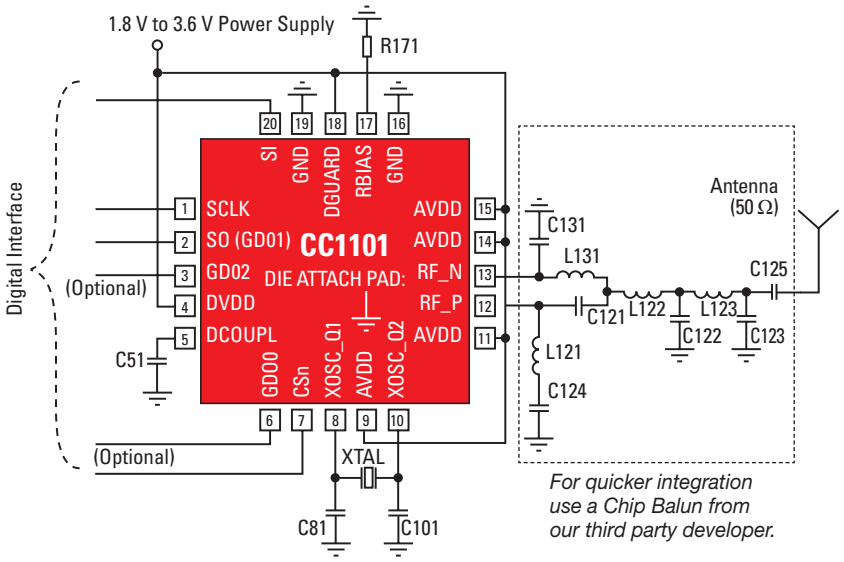
- Sub-1 GHz FSK/GFSK/MSK/ASK/OOK RF transceiver
- 1.2 to 500-kBaud data rate
- Low-power, low system cost
- Sleep current: 200 nA
- 90-µs PLL lock time: 240 µs from sleep to RX/TX
- On-chip support for sync word detection, address check, flexible packet length and automatic CRC checking
- Separate 64-Byte RX and TX data FIFOs (enable burst mode data transmission)
- Suitable for systems targeting compliance with EN 300 200 (Europe) and FCC CFR Part 15 (U.S.)

Benefits

- Fast development time and low system cost
- Flexible optimization of range power
- Enables use of inexpensive microcontroller
- Enables adaptive channel selection with increased robustness and coexistence of the wireless link
- Small size solution

Applications

- Wireless alarm and security systems
- Automatic meter reading
- Industrial monitoring and control
- Home and building automation
- Wireless networks targeting IEEE 802.15.4g standard



The CC1101 is pin and register compatible with the 2.4-GHz CC2500 transceiver.

Development tools and software

- CC1101DK-433 MHz Development Kit
- CC1101DK-868/915 MHz Development Kit
- CC1101EMK-433 MHz Evaluation Module Kit
- CC1101EMK-868/915 MHz Evaluation Module Kit
- SimpliciTI™ software protocol
- Wireless M-Bus

General Characteristics

Parameter (433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions:					
Frequency range	300	—	348	MHz	
	387	—	464	MHz	
	779	—	928	MHz	
Operating temperature range	–40	—	+85	°C	
Operating supply voltage	1.8	—	3.6	V	
Data rate (programmable)	1.2	—	500	kBaud	
Output power (programmable)	–30	—	+12	dBm	
Receiver sensitivity, 1.2 kBaud	—	–113	—	dBm	1.2 kBaud, 868 MHz, 1% packet error rate
Power consumption					
Current consumption RX, 868 MHz	—	14.7	—	mA	Input well above sensitivity limit
Current consumption TX	— —	15.0 30.0	— —	mA mA	0 dBm 12 dBm
Current consumption, power down	—	<1	—	µA	

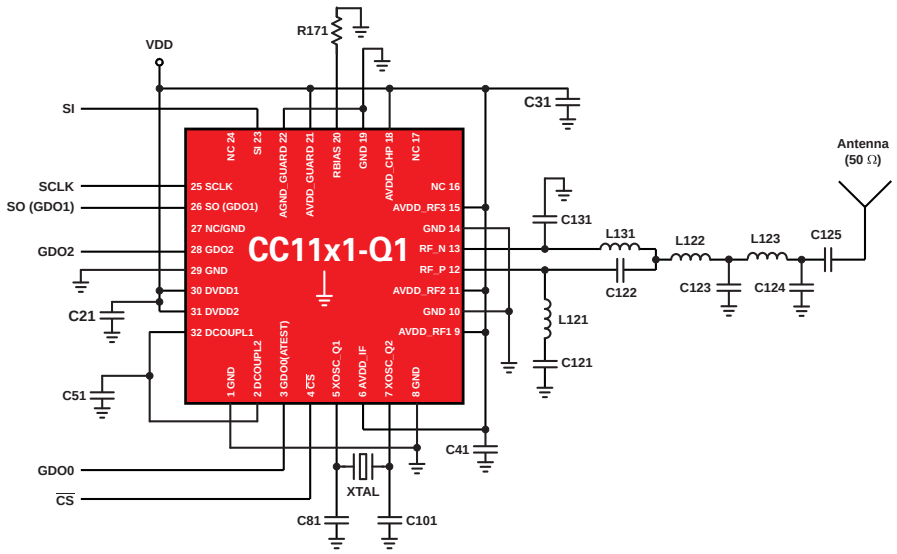
As part of the CC1101 family, the CC1101-Q1 (Transceiver), CC1131-Q1 (Receiver) and CC1151-Q1 (Transmitter) are available as automotive-qualified versions in accordance to AEC-Q100 Grade 1. All three parts come in a pin-to-pin and software-compatible 5×5-mm QFN-32 package and offer an extended temperature range from –40 to +125°C, tighter specification values and guaranteed sensitivity values. See 36 for more information.

CC1101-Q1

Sub-1-GHz Automotive-Qualified RF Transceiver
CC1101-Q1

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1101-q1**

Integrated solution provides high performance. The CC1101-Q1 is a highly integrated, multichannel RF transceiver designed for low-power wireless applications in the 315/433/868/915-MHz ISM bands. The CC1101-Q1 is the automotive derivate of the CC1101 transceiver qualified in accordance to AEC-Q100 with extended electrical specification and extended temperature range up to +125°C.



The CC1101-Q1 is register compatible with the CC1101 transceiver.

Key features
- Sub-1 GHz FSK/GFSK/MSK/ASK/OOK RF transceiver
- 1.2 to 250-kBaud data rate
- Low-power, low system cost
- Sleep current: 700 nA
- 90-µs PLL lock time: 240 µs from sleep to RX/TX
- On-chip support for sync word detection, address check, flexible packet length and automatic CRC checking
- Separate 64-Byte RX and TX data FIFOs (enable burst mode data transmission)
- Suitable for systems targeting compliance with EN 300 200 (Europe) and FCC CFR Part 15 (U.S.)

Benefits
- Fast development time and low system cost
- Flexible optimization of range power
- Enables use of inexpensive microcontroller
- Enables adaptive channel selection with increased robustness and coexistence of the wireless link
- Easy system scaling from unidirectional to bidirectional systems through compatible device family

Applications
- Remote keyless entry
- Passive entry and passive start
- TPMS receiver
- Garage door opener
- High-temperature sensors

Development tools and software
- CC1101DK-433 MHz Development Kit
- CC1101DK-868/915 MHz Development Kit
- SimpliciTI™ software protocol

General Characteristics

Parameter (315, 433MHz, 3V, 25°C)	Min	Typ	Max	Unit
Operating conditions:				
Frequency range	310	—	348	MHz
	387	—	464	MHz
	779	—	928	MHz
Operating temperature	–40	—	125	°C
Operating voltage	1.8	—	3.6	V
Data rate (programmable)	1.2	—	250	kBaud
Output power (programmable)	–30	—	+12	dBm
Receiver sensitivity, 1.2 kBaud	—	–114	—	dBm
Current consumption				
Current consumption, RX	—	15.5	—	mA
Current consumption, TX, +10 dBm	—	29.5	—	mA
Current consumption, TX, 0 dBm	—	14.6	—	mA

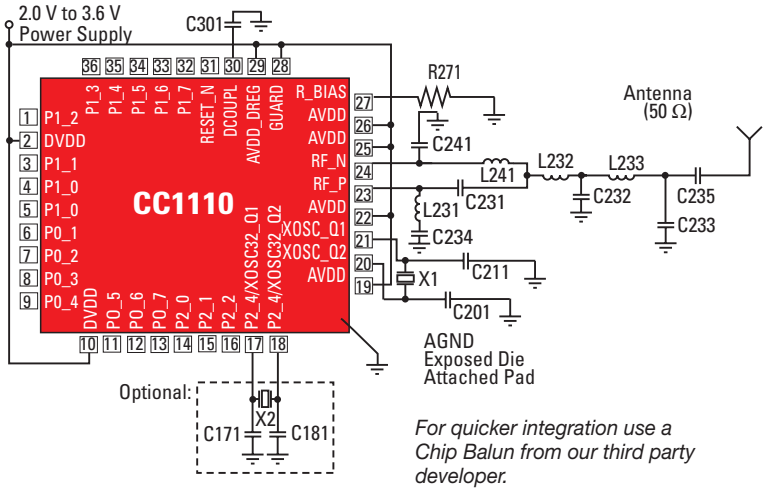
CC1110

RF System-on-Chip Solution
CC1110F8/F16/F32

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/product/cc1110f32**
See also: **www.ti.com/product/tps62730**

Radio, MCU and Flash all-in-one chip

The CC1110Fx family consists of three Systems-on-Chip designed for low-power and low-voltage wireless communication applications. With a 315/433/868/915-MHz radio transceiver, a single-cycle 8051 MCU, 8/16/32-kB Flash memory and additional peripherals, these unique all-in-one devices make it easier than ever to finish your design faster while offering numerous application possibilities.



For quicker integration use a Chip Balun from our third party developer.

Key features

- High-performance, low-power 8051 MCU core, typically with 8× the performance of a standard 8051
- Utilizes the high-performance CC1101 RF transceiver core
- 8/16/32-kB in-system programmable Flash
- 1/2/4-kB SRAM (with data retention in all power modes)
- 8- to 12-bit ADC, 21 general purpose I/O pins, on-chip timers
- Very few external components required
- Four flexible power modes for reduced power consumption
- Very fast transition times from sleep modes to active mode enables ultra-low average power consumption in low duty-cycle systems
- In deep-sleep modes the system can wake up on external interrupts or real-time counter events
- Low current consumption
- AES-128 encryption coprocessor
- Powerful DMA functionality
- Real-time clock with low-power 32.768-kHz crystal oscillator or internal 34-kHz RC Oscillator

Benefits

- Complete solution on one single chip
- Ideal for low-power, battery operated systems
- Robust and secure link with very good coexistence

Applications

- Alarm and security
- Automatic meter reader/ smart metering
- Consumer electronics
- Wireless networks targeting IEEE 802.15.4g standard

Development tools and software

- CC1110/CC1111DK Development Kit
- CC1110EMK-433 MHz Evaluation Module Kit
- CC1110EMK-868/915 MHz Evaluation Module Kit
- SimpliciTI™ software protocol
- Wireless M-Bus
- CC1110DK-MINI

General Characteristics

Parameter					
(433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions					
Frequency range	300	—	348	MHz	
	391	—	464	MHz	
	782	—	928	MHz	
Operating temperature range	–40	—	+85	°C	
Operating supply voltage	2.0	—	3.6	V	
Data rate (programmable)	1.2	—	500	kBaud	
Output power (programmable)	–30	—	10	dBm	
Receiver sensitivity	—	–111	—	dBm	1.2 kBaud, 868 MHz, 1% packet error rate
Current consumption					
MCU active and RX mode	—	17	—	mA	System clock at 203 kHz
MCU active and TX mode, 0 dBm	—	20/21	—	mA	MCU running at full speed (26 MHz), radio in TX mode, 0-dBm output power
Power mode 2	—	0.5	—	µA	32 kHz RC-oscillator (or 32.768-kHz crystal oscillator) and sleep timer running
Power mode 3	—	0.3	—	µA	No clocks running, power On Reset (POR) active, can wake up on external interrupt
Wake-up and timing					
From power mode 2 or 3 to active	—	100	—	µs	Digital regulator and high-speed oscillators off, start-up of regulator and high-speed RC Oscillator
From active to RX or TX	—	90	—	µs	Time from enabling 26-MHz crystal oscillator and the radio part until RX or TX starts

CC1111

RF System-on-Chip with Integrated Full-Speed USB Controller
CC1111F8/F16/F32

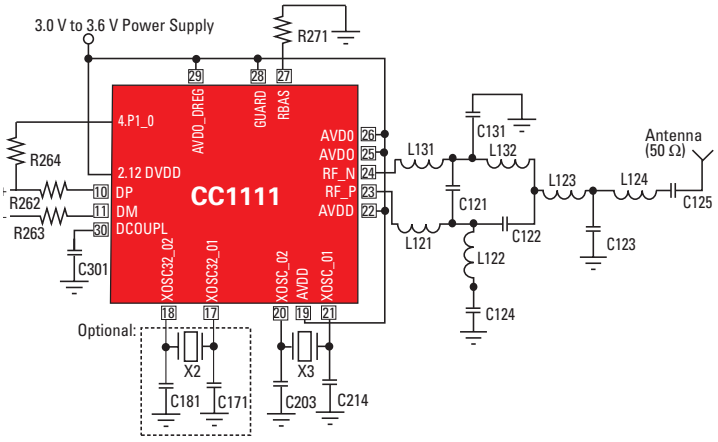
Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1111F8**

Radio, MCU, Flash and USB all-in-one chip

The CC1111 is a System-on-Chip (SoC) with USB controller for low-power wireless applications in the 315/433/868/915-MHz frequency bands. The CC1111 combines the excellent performance of the industry-leading CC1101 RF transceiver with an enhanced MCU, full-speed USB 2.0, 32-kByte Flash memory, 4-kBytes RAM, 128-bit AES hardware encryption and many other powerful features.

Key features

- Full-speed USB 2.0 with 1-kB USB FIFO, 12-Mbps transfer rate, five bidirectional endpoints with support for bulk, interrupt and isochronous transfers
- Sub-1 GHz RF transceiver identical to the CC1101:
  - Highly configurable with support for 1.2- to 500-kBaud data rate and FSK, MSK, GFSK and OOK/ASK modulation
- Very low current consumption:
  - 0.3 µA in lowest power mode
- 8/16/32-kB in-system programmable Flash
- 1/2/4-kB SRAM (with data retention in all power modes)
- Excellent receiver sensitivity and robustness
- 128-bit AES supported in hardware coprocessor
- 8-channel, 8- to 14-bit ADC with up to eight inputs
- Industry standard I^2S interface for digital audio data, full-duplex, mono and stereo support, configurable sample rate and sample size
- Direct memory access which reduces MCU load



CC1111 application circuit.

Benefits

- Complete solution on one single chip
- Ideal for low-power battery operated systems
- Robust and secure link with very good coexistence
- Powerful and flexible development tools and reference designs available

Applications

- Alarm and security applications
- Automatic meter reading
- Industrial monitoring and control
- Home and building automation

Development tools and software

- CC1110/CC1111DK Development Kit
- CC1111EMK-868/915 Evaluation Module Kit
- SimpliciTI™ software protocol

General Characteristics

Parameter (433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit	Condition
Operating conditions					
Frequency range	300	—	348	MHz	
	391	—	464	MHz	
	782	—	928	MHz	
Operating temperature range	0	—	85	°C	
Operating supply voltage	3.0	—	3.6	V	
Data rate (programmable)	1.2	—	500	kBaud	
Output power (programmable)	–30	—	10	dBm	
Receiver sensitivity	—	–110	—	dBm	1.2 kBaud, 1% packet error rate
Current consumption					
MCU active and RX mode	—	19	—	mA	
MCU active and TX mode, 0 dBm	—	20/21	—	mA	
Power mode 2	—	0.5	—	µA	
Power mode 3	—	0.3	—	µA	
Wake-up and timing					
From power mode 2 or 3 to active	—	100	—	µs	Digital regulator and high-speed oscillators off, start-up of regulator and high-speed RC oscillator
From active to RX or TX	—	90	—	µs	Time from enabling 26-MHz crystal oscillator and the radio part until RX or TX starts

CC1131-Q1

Sub-1-GHz Automotive-Qualified RF Receiver
CC1131-Q1

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1131-q1**

Integrated solution provides high performance. The CC1131-Q1 is a highly integrated, multichannel RF receiver designed for low-power wireless applications in the 315/433/868/915-MHz ISM bands. The CC1131-Q1 is the receiver only derivate of the CC1101-Q1 transceiver qualified in accordance to AEC-Q100 with extended electrical specification and extended temperature range up to +125°C.

Key features

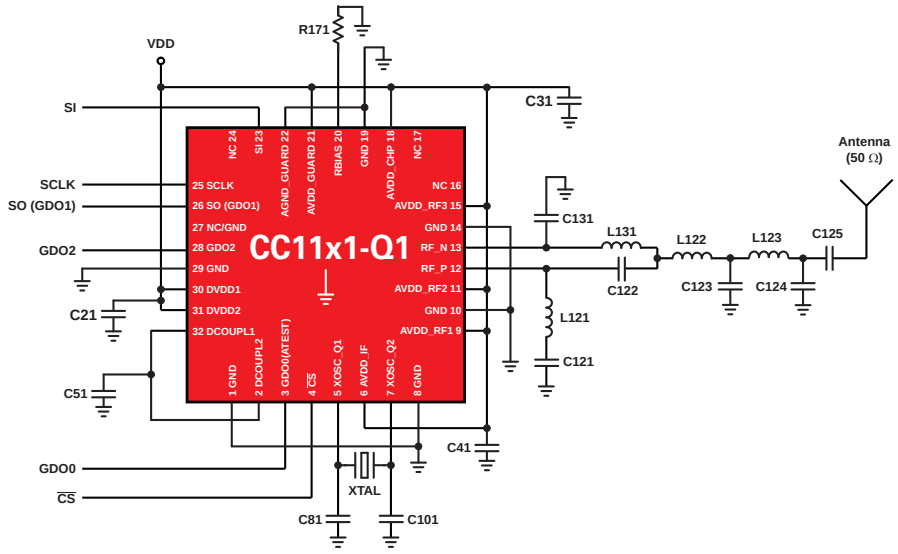
- Sub-1 GHz FSK/GFSK/MSK/ASK/OOK RF receiver
- 1.2- to 250-kBaud data rate
- Low-power, low system cost
- Sleep current: 700 nA
- 90-µs PLL lock time: 240 µs from sleep to RX
- On-chip support for sync word detection, address check, flexible packet length and automatic CRC checking
- 64-Byte RX data FIFOs (enable burst mode data reception)
- Suitable for systems targeting compliance with EN 300 200 (Europe) and FCC CFR Part 15 (U.S.)

Benefits

- Fast development time and low system cost
- Flexible optimization of range power
- Enables use of inexpensive microcontroller
- Enables adaptive channel selection with increased robustness and coexistence of the wireless link
- Easy system scaling from unidirectional to bidirectional systems through compatible device family

Applications

- Remote keyless entry
- Passive entry and passive start
- TPMS receiver
- Garage door opener
- High-temperature sensors



The CC1131-Q1 is register compatible with the CC1101-Q1 transceiver.

Development tools and software

- CC1101DK-433 MHz Development Kit
- CC1101DK-868/915 MHz Development Kit
- SimpliciTI™ software protocol

General Characteristics

Parameter (315, 433MHz, 3V, 25°C)	Min	Typ	Max	Unit
Operating conditions:				
Frequency range	310	—	348	MHz
	387	—	464	MHz
	779	—	928	MHz
Operating temperature	–40	—	125	°C
Operating voltage	1.8	—	3.6	V
Data rate (programmable)	1.2	—	250	kBaud
Receiver sensitivity, 1.2kBaud	—	–114	—	dBm
Current consumption				
Current consumption, RX	—	15.5	—	mA

CC1150

Multi-Channel RF Transmitter
CC1150

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1150**

Integrated solution provides low cost and high performance

The CC1150 is a highly integrated, multi-channel RF transmitter designed for low-power wireless applications in the 315/433/868/915-MHz ISM band.

Key features

- Best-in-class price/performance ratio
- Many powerful digital features:
  - Full packet handling including preamble generation, sync word insertion, flexible packet length and automatic CRC generation
- Reference design with two-layer PCB with all components mounted on the same side
- Programmable high data rate from 1.2 to 500 kBaud
- Programmable output power up to +12 dBm
- Low-transmit current consumption
- Fast startup time (0.3 µs)
- Packaging: very small footprint 4×4 mm, 20-pin QLP package

Benefits

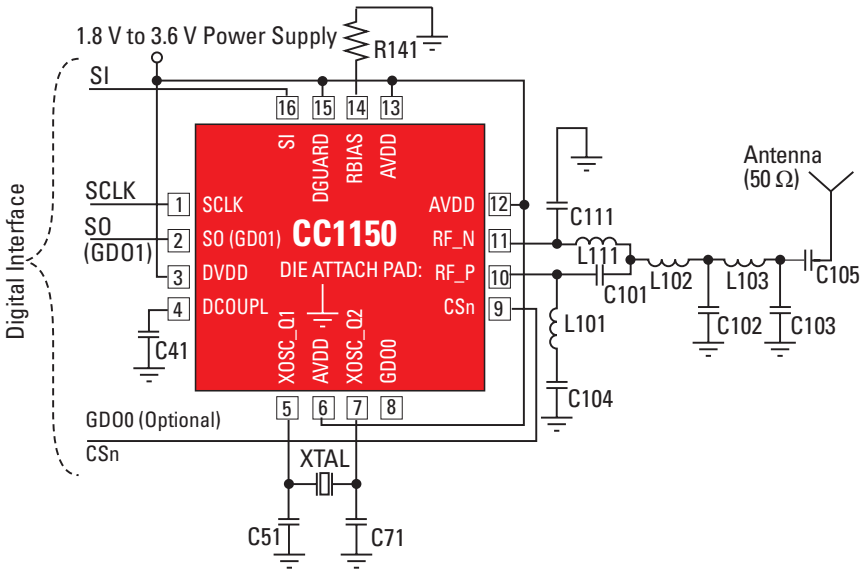
- Fast development time and low system cost
- Flexible optimization of range versus power
- Enables use of inexpensive microcontroller
- Small solution size

Applications

- Home and building automation
- Automatic meter reading
- Wireless alarm and security systems
- Industrial monitoring and control
- Wireless sensor networks
- Consumer electronics

Development tools and software

- CC1101DK-868/915 MHz Evaluation Module Kit
- CC1101DK-433 MHz Development Kit



CC1150 application circuit.

General Characteristics

Parameter (433/868 MHz, 3.0 V, 25°C)	Min	Typ	Max	Unit
Operating conditions				
Frequency range	300	—	348	MHz
	400	—	464	MHz
	800	—	928	MHz
Output power (programmable)	–30	—	+10	dBm
Operating temperature range	–40	—	+85	°C
Operating supply voltage	1.8	—	3.6	V
Data rate (programmable)	1.2	—	500	kBaud
Power consumption				
Current consumption TX, (+10 dBm) 433 MHz	—	26.4	—	mA
Current consumption TX, (0 dBm) 433 MHz	—	14.9	—	mA
Current consumption, power down	—	<1	—	µA

CC1151-Q1

Sub-1-GHz Automotive-Qualified RF Transmitter
CC1151-Q1

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC1151-q1**

Integrated solution provides high performance. The CC1151-Q1 is a highly integrated, multichannel RF transmitter designed for low-power wireless applications in the 315/433/868/915-MHz ISM bands. The CC1151-Q1 is the transmitter only derivate of the CC1101-Q1 transceiver qualified in accordance to AEC-Q100 with extended electrical specification and extended temperature range up to +125°C.

Key features

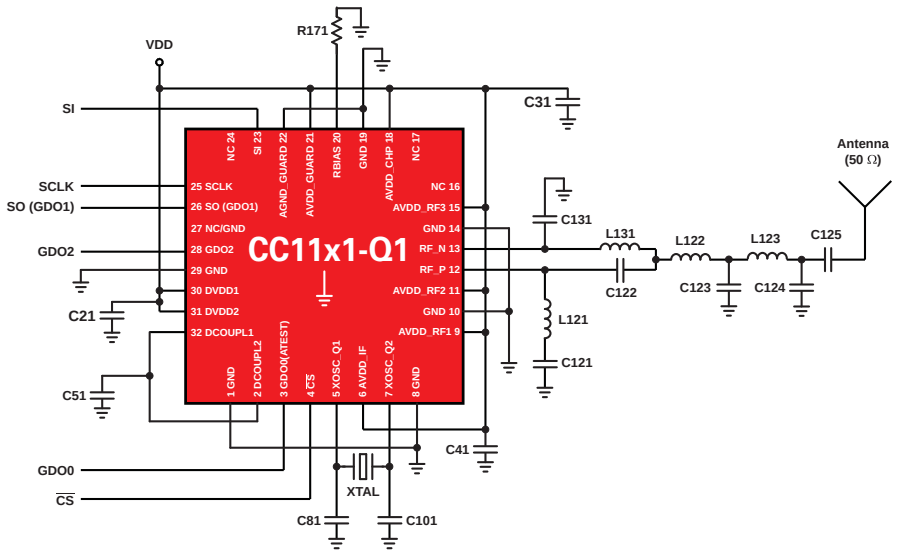
- Sub-1 GHz FSK/GFSK/MSK/ASK/OOK RF transmitter
- 1.2- to 250-kBaud data rate
- Low-power, low system cost
- Sleep current: 700 nA
- 90-µs PLL lock time: 240 µs from sleep to TX
- On-chip support for sync word insertion, address insertion, flexible packet length and automatic CRC insertion
- 64-Byte TX data FIFOs (enable burst mode data transmission)
- Suitable for systems targeting compliance with EN 300 200 (Europe) and FCC CFR Part 15 (U.S.)

Benefits

- Fast development time and low system cost
- Flexible optimization of range power
- Enables use of inexpensive microcontroller
- Enables adaptive channel selection with increased robustness and coexistence of the wireless link
- Easy system scaling from unidirectional to bidirectional systems thru compatible device family

Applications

- Remote keyless entry
- Passive entry and passive start
- Garage door opener
- High-temperature sensors



The CC1151-Q1 is register compatible with the CC1101-Q1 transceiver.

Development tools and software

- CC1101DK-433 MHz Development Kit
- CC1101DK-868/915 MHz Development Kit
- SimpliciTI™ software protocol

General Characteristics

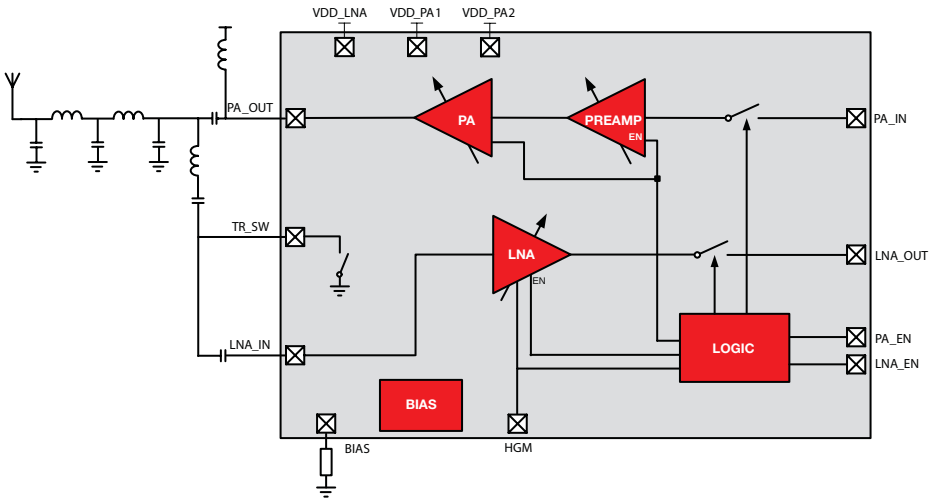
Parameter (315, 433MHz, 3V, 25ºC)	Min	Typ	Max	Unit
Operating conditions:				
Frequency range	310	—	348	MHz
	387	—	464	MHz
	779	—	928	MHz
Operating temperature	–40	—	125	ºC
Operating voltage	1.8	—	3.6	V
Data rate (programmable)	1.2	—	250	kBaud
Output power (programmable)	–30	—	+12	dBm
Current consumption				
Current consumption, TX, +10 dBm	—	29.5	—	mA
Current consumption, TX, 0 dBm	—	14.6	—	mA

CC1190

Sub-1-GHz Front End (850–950 MHz)
CC1190

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/CC1190**

The CC1190 is range extender for the sub-1-GHz low-power RF transceivers and System-on-Chip (SoC) devices from Texas Instruments. The CC1190 integrates a power amplifier (PA), a low noise amplifier (LNA), switches, and RF matching for the design of high-performance wireless systems. The CC1190 increases the link budget by providing a power amplifier for increased output power, and an LNA with low noise figure for improved sensitivity. The CC1190 provides an efficient and easy-to-use range extender in a compact 4×4mm package.



CC1190 block diagram.

Key features

- Seamless interface to sub-1-GHz low-power RF devices from TI
- Up to 27 dBm (0.5 W) output power
- 2.9 dB LNA noise figure including switch and external antenna match
- Few external components: the integrated PA, LNA, switches, matching network and inductors improve system performance over typical discrete front end solutions
- High transmit power efficiency PAE=50% at 26 dBm output power

Benefits

- An integrated front end reduces development time by up to 70%
- Using the CC1190 with even a small 6dB increase in link budget doubles the range, making the CC1190 a great choice for remote monitoring
- A compact reference design reduces the board space for a front end by up to 50%

Applications

- Wireless sensor networks
- Wireless metering infrastructure
- Wireless security systems
- Wireless long range remote monitoring

Development tools and software

- CC1101CC1190EMK915 Evaluation Module Kit

General Characteristics

Parameter	Min	Typ	Max	Unit
Supply range	2.0	—	3.7	V
Frequency range	850	—	950	MHz
Ambient temperature range	–40	—	85	°C
Power down current	—	50	200	nA
RX mode				
Receive current, high gain mode	—	3	—	mA
Receive current, low gain mode	—	26	—	µA
Gain, high gain mode	—	11.6	—	dB
Gain, low gain mode	—	–6	—	dB
Input, 1-dB compression, high gain mode	—	–12.3	—	dB
Noise figure, high gain mode	—	2.9	—	dB
TX mode				
Transmit current, 26.5dBm output power	—	302	—	mA
Output power	—	26.5	—	dBm
Power added efficiency, PAE	—	48	—	%
Output 1-dB compression	—	24	—	dBm

CC1120, CC1121, CC1125, CC1175 and CC1200

High-Performance RF Transceiver for Narrowband Systems
CC1120, CC1121, CC1125, CC1175, CC1200

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/cc1120**

See also: www.ti.com/product/tps62730

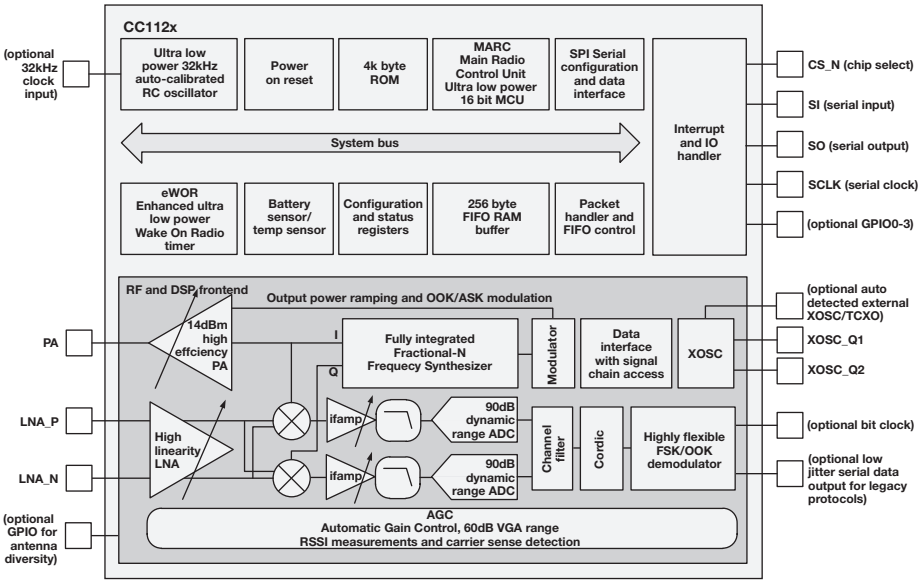
The RF Performance Line is a family of industry's highest performance RF parts, including RF transceivers and a transmitter. The parts operate in the 169/315/433/868/950MHz frequency bands. RF Performance Line offers a new level of RF selectivity and blocking. With 65dB adjacent channel rejection and 90dB blocking, robust applications can be built even without an external SAW filter.

The RF Performance Line devices are distinguished by supporting different RF channel bandwidths, data rates and RF regulations. See tables for RF regulations supported and feature set.

Complete RF and MCU development is done with the RF Performance Line development kit. Out-of-the box, RF range and performance can be tested using the free SmartRF™ Studio and RF Packet Sniffer PC software. Code development can be done on the MSP430F5438A used in the development kit, which also includes peripherals like a dot matrix LCD display and various sensors.

Key features

- Industry leading RF blocking and selectivity:
  - 65dB adjacent channel rejection at 12.5kHz offset
  - 90dB blocking
- High output power (up to +16dBm) and excellent sensitivity (Up to 145db link budget)
- WaveMatch; Advanced DSP sync detector with high sensitivity and strong noise and fast setting
- Advanced RX sniff mode with low power without sacrificing performance



CC112x block diagram.

Benefits

- First pass installation success. The RF chip market is growing 30%YoY, and robust RF is the key to communicate reliably in presence of interference => lower field install cost.
- The first fully integrated ETSI Category 1 radio on the market. Significant cost reduction compared to today's discrete solutions.
- Long range, 10s of kilometers out-of-the-box with the development kit.
- More reliable links, no false sync detects in noise.
- <3mA RX sniff mode current consumption. Extended battery life.

Applications

- Smart metering
- Alarm and security systems
- Industrial automation

Development tools and software

- RF Performance Line Development Kit
- SmartRF Studio

CC1120, CC1121, CC1125, CC1175 and CC1200 (continued)

Parameter	CC1175 (only TX)	CC1121	CC1120	CC1125	CC1200 (Q1 2013)
RCR 30	Yes	No	Yes	Yes	Yes
ARIB T96, ARIB T108	Yes	Yes	Yes	Yes	Yes
ETSI EN 300-220 Cat 1	Yes	No	Only 169MHz & 433MHz	Yes	No
ETSI EN 300-220 Cat 2	Yes	Yes	Yes	Yes	Yes
FCC Part 15	Yes	Yes	Yes	Yes	Yes
FCC Part 24	Yes	No	Yes	Yes	Yes
FCC Part 90					
(Mask D, E, G, J)	Yes	No	Yes	Yes	Yes
FCC Part 101	Yes	No	Yes	Yes	Yes
ETSI EN 54-25	Yes	Yes	Yes	Yes	Yes
ETSI 300-113 TN	Yes	No	No	TX only	No

General Characteristics

	CC1120	CC1121	CC1175	CC1125	CC1200
Device Type	Transceiver	Transceiver	Transmitter	Transceiver	Transceiver
Minimum RX Filter Bandwidth (kHz)	7.8	41.7	N/A	3.5	12.5
Frequency (Min)	164MHz, 410MHz, 820MHz	164MHz, 410MHz, 820MHz	164MHz, 410MHz, 820MHz	164MHz, 410MHz, 820MHz	410MHz, 820MHz
Frequency (Max)	192MHz, 480MHz, 960MHz	192MHz, 480MHz, 960MHz	192MHz, 480MHz, 960MHz	192MHz, 480MHz, 960MHz	480MHz, 960MHz
Data Rate (Max) (kbps)	200	200	200	200	1000
Phase noise @170MHz, 10kHz (dBc/Hz)	–111	–111	–115	–115	–110
Operating Voltage (Min) (V)	2.0	2.0	2.0	2.0	2.0
Operating Voltage (Max) (V)	3.8	3.8	3.8	3.8	3.8
RX Current (Lowest) (mA)	17	17	n/a	17	17
Standby Current (µA)	0.3	0.3	0.3	0.3	0.3
Modulation Techniques	2-FSK, 2-GFSK, 4-FSK, 4-GFSK, MSK, OOK	2-FSK, 2-GFSK, 4-FSK, 4-GFSK, MSK, OOK	2-FSK, 2-GFSK, 4-FSK, 4-GFSK, MSK, OOK	2-FSK, 2-GFSK, 4-FSK, 4-GFSK, MSK, OOK	2-FSK, 2-GFSK, 4-FSK, 4-GFSK, MSK, OOK, extended support for 802.15.4g PHY FSK
Sensitivity (Best) (dBm)	-123	-117	n/a	-127	-122
Adjacent Channel Selectivity (dB)	64	61	n/a	65	55
RF Blocking (+/- 10MHz) (dB)	90	86	n/a	104	90
TX Power (Max) (dBm)	16	16	16	16	16
AES-128 Accelerator	NO	NO	NO	NO	YES

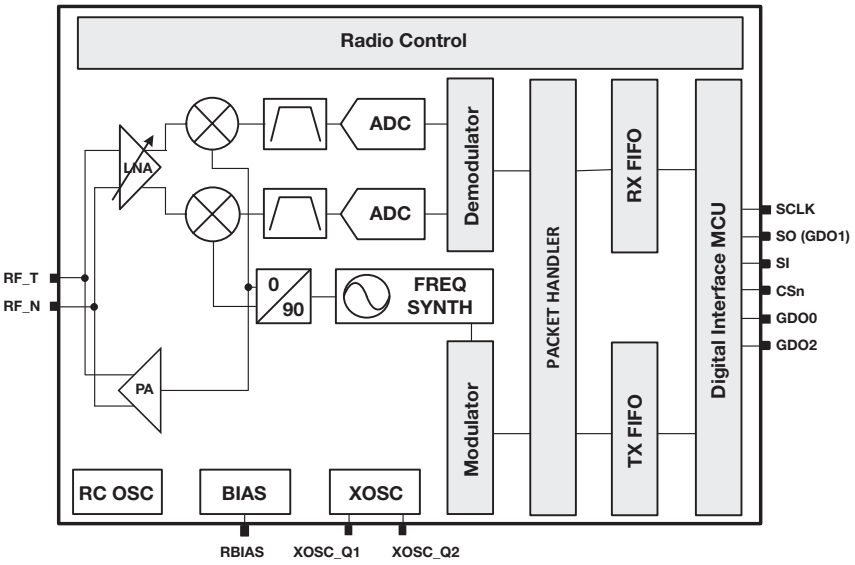
CC110L

Value Line Transceiver
CC110L, CC113L, CC115L

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/cc110L**

The RF Value Line is a family of low cost RF parts, including a transceiver, a receiver and a transmitter. The parts are pin, register and code compatible, and they can be used to migrate between 1-way and 2-way RF solutions using the same PCB for both options. The parts operate in the 315/433/868/915MHz bands. The RF Value Line is based on TI's very popular CC1101 RF transceiver, and the devices have inherited the key benefits of this platform. This includes very flexible modulation formats and data rates to be compatible with almost any existing RF solution, advanced digital features and a vast pool of design resources with more than 50 application notes have been published on the platform.

To make RF development easier and more accessible an RF BoosterPack for the MSP430 LaunchPad is also available. The new 430BOOST-CC110L RF BoosterPack includes ETSI-compliant and FCC-certified modules to help speed development time, reduce certification costs and eliminate barriers associated with the RF hardware design process.



CC110L block diagram.

Key features

- CC1101 RF performance
- Flexible RF modulation formats 2-FSK, 4-FSK, GFSK and OOK, data rates from 0.6 to 600kbps
- All Value Line devices are pin, register and code compatible
- $1 price tag on transmitter + receiver bundle

Benefits

- Proven RF performance where millions of these devices are being used every day
- Backwards compatible with existing sub-1-GHz systems
- Easy to switch between 1-way and 2-way solutions
- Complete 1-way RF link for $1 in high volumes (100k+)

Applications

- Cost-sensitive 1-way and 2-way sub-1-GHz RF applications
- Remote controls
- Toys
- Home and building automation
- Alarm and security systems

Development tools and software

- RF Value Line Development Kit
- SmartRF Studio PC software
- CC110L RF BoosterPack for MSP430 LaunchPad

General Characteristics

Device Type	CC110L	CC113L	CC115L
Frequency (Max)	300MHz, 387MHz, 779MHz	300MHz, 387MHz, 779MHz	300MHz, 387MHz, 779MHz
Data Rate (Max) (kbps)	348MHz, 464MHz,928MHz	348MHz, 464MHz,928MHz	348MHz, 464MHz,928MHz
Operating Voltage (Min) (V)	600	600	600
Operating Voltage (Max) (V)	1.8	1.8	1.8
RX Current (Lowest) (mA)	3.6	3.6	3.6
Standby Current (µA)	14	14	NA
Wake-up Time (PD-->RX/TX) (µS)	0.2	0.2	0.2
Modulation Techniques	240	240	240
Sensitivity (Best) (dBm)	2-FSK, 4-FSK, GFSK, OOK	2-FSK, 4-FSK, GFSK, OOK	2-FSK, 4-FSK, GFSK, OOK
TX Power (Max) (dBm)	–116	–116	NA
Transmit current, 26.5dBm output power	12	NA	12
Output power	—	26.5	—
Power added efficiency, PAE	—	48	—
Output 1-dB compression	—	24	—

CC2544

2.4-GHz RF Value Line SoC with 32kB Flash, 31 GPIO, I²C, SPI and UART
CC2543, CC2544 and CC2545

Get samples, evaluation modules and application notes at: **www.ti.com/product/CC2543**

CC2543/44/45 is a family of 2.4GHz RF Value Line System-on-Chip (SoC) with MCU, 32KB Flash and 1/2KB RAM on a single die. They feature 2-Mbps data rate, 102dB link budget and <1µA sleep current with sleep timer running. The family members are distinguished by different number of general I/O pins, and CC2544 has a USB interface.

The CC2543-CC2544 Development Kit provides a complete hardware performance test platform and generic software development environment for 2.4-GHz RF proprietary applications. The kit includes two CC2543-based RF evaluation modules, one CC2544-based USB dongle, general purpose development boards (SmartRF05EB) for software and hardware prototyping, cables, antennas and documentation to get you up and running with the CC2543, CC2544, and CC2545 quickly and easily.

Complete RF and MCU development is done with the CC2543-CC2544 Development Kit. Out-of-the box, RF range and performance can be tested using the free SmartRF Studio. Code development can be done on embedded 8051 core used in the development kit, which also includes peripherals like a dot matrix LCD display and various other interfaces.

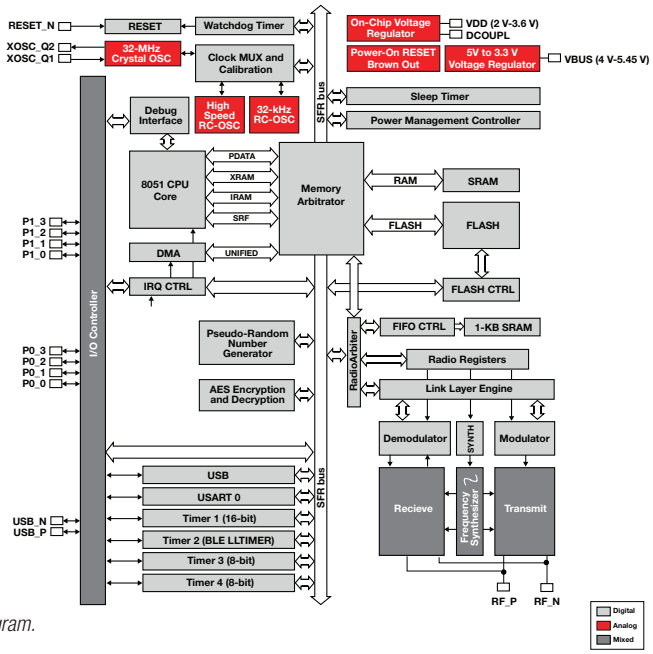
Key features

Data throughput:
- 2-Mbps radio
- Up to 256-Byte packet length
- Quick RX/TX turnaround time

Link budget:
- +4dBm output power
- –98dBm sensitivity @ 250kbps
- –90dBm sensitivity @ 2Mbps

Power consumption:
- <1µA sleep current
- Quick transition between power modes

Low-cost design:
- Integrated MCU, RF, memory and USB
- Ultra low-cost crystal, few external components, small PCB antennaes



CC2544 block diagram.

Benefits

- High effective data rate, up to 1.6Mbps sustainable throughput
- Less time on-air and lower power consumption
- Up to 100dB link budget
- Long range with small antennas
- Several years of battery life on AA cells possible depending on application
- Perfect fit for wireless 2.4-GHz consumer applications
- Good fit for PC keyboard and mouse

Applications

- Wireless mouse and keyboard
- Low-cost remote controls, toys
- Low-cost consumer applications

Development tools and software

- CC2543-CC2544 Development Kit
- CC2545 Evaluation Module Kit
- SmartRF Studio
- IAR Embedded Workbench

General Characteristics

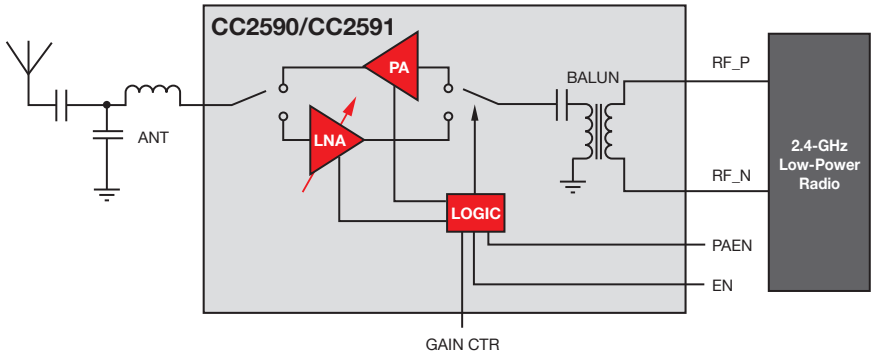
	CC2543	CC2544	CC2545
Frequency (Min)	2379MHz	2380MHz	2379MHz
Frequency (Max)	2496MHz	2495MHz	2496MHz
Device type	System-on-Chip	System-on-Chip	System-on-Chip
Flash size (KB)	32	32	32
RAM size (KB)	1	2	1
Data rate (Max) (kbps)	2000	2000	2000
Operating voltage (Min) (V)	2.0	2.0	2.0
Operating voltage (Max) (V)	3.6	3.6	3.6
RX current (Lowest) (mA)	21.2	22.5	20.8
Standby current	0.9µA	1mA (USB suspend)	0.9µA
Modulation techniques	GFSK, MSK	GFSK, MSK	GFSK, MSK
Sensitivity (Best) (dBm)	–98	–95	–98
TX Power (Max) (dBm)	4	4	4
Features	I²C, UART, SPI, 16 GPIO	USB, UART, SPI, 8 GPIO	I²C, UART, SPI, 31 GPIO

CC2590, CC2591

2.4 GHz RF Front End
CC2590, CC2591

Get samples, datasheets, evaluation modules and application notes at: **www.ti.com/sc/device/CC2590** and **www.ti.com/sc/device/CC2591**

CC2590 and CC2591 are 2.4-GHz range extenders specially designed for all existing and future 2.4-GHz RF transceivers and System-on-Chip (SoC) solutions from TI. CC2590/CC2591 increase the link budget by providing a power amplifier for improved output power and an LNA with low noise figure for improved receiver sensitivity. They contain PA, LNA, switches, RF-matching, and balun for simple design of high-performance wireless applications.



CC2590/CC2591 block diagram.

Key features

CC2590

- Up to +14-dBm output power
- 22-mA transmit current at 3 V at +12-dBm output power
- 4.6-dB LNA noise figure including RX/TX switch and antenna match

CC2591

- Up to +22-dBm output power
- Up to +28-dB increased link budget
- 112-mA transmit current at 3 V at +20-dBm output power
- 4.8-dB LNA noise figure including RX/TX switch

CC2590/CC2591

- Seamless interface to TI's 2.4-GHz 802.15.4 low-power RF devices
- 6-dB typ improved sensitivity on CC24xx, CC2500, CC2510 and CC2511
- Very few external components: integrated PA, LNA, switches, inductors, balun and matching network
- Low receive current: 3.4 mA in HIGH gain mode, 1.7 mA in LOW gain mode
- 100 nA in power down
- Digital control of LNA gain by HGM pin
- Packaging: RoHS-compliant, 4×4 mm QFN-16

Development tools

- CC2530-CC2591EMK Evaluation Module Kit
- CC2520-CC2591EMK Evaluation Module Kit

CC2590 General Characteristics

Parameter	Min	Typ	Max	Unit
Supply range	2.0	—	3.6	V
Frequency range	2400	—	2483.5	MHz
Ambient temperature range	–40	—	85	°C
Power down current	—	0.1	0.3	µA
RX mode				
Receive current, high gain mode	—	3.4	4	mA
Receive current, low gain mode	—	1.8	2	mA
Gain, high gain mode	—	11.4	—	dB
Gain, low gain mode	—	0	—	dB
Input, 1-dB compression, high gain mode	—	–21	—	dB
Noise figure, high gain mode	—	4.6	—	dB
TX mode				
Transmit current, 12-dBm output power	—	22	—	mA
Output power	—	12	—	dBm
Power added efficiency, PAE	—	23	—	%
Output 1-dB compression	—	10.4	—	dBm

CC2591 General Characteristics

Parameter	Min	Typ	Max	Unit
Supply range	2.0	—	3.6	V
Frequency range	2400	—	2483.5	MHz
Ambient temperature range	–40	—	85	°C
Power down current	—	0.1	0.3	µA
RX mode				
Receive current, high gain mode	—	3.4	4	mA
Receive current, low gain mode	—	1.7	2	mA
Gain, high gain mode	—	11	—	dB
Gain, low gain mode	—	1	—	dB
Noise figure, high gain mode	—	4.8	—	dB
Input, 1-dB compression, high gain mode	—	–17	—	dB
TX mode				
Transmit current, 20-dBm output power	—	100	—	mA
Output power	—	20	—	dBm
Power added efficiency, PAE	—	33	—	%
Output 1-dB compression	—	19	—	dBm

TMS37157

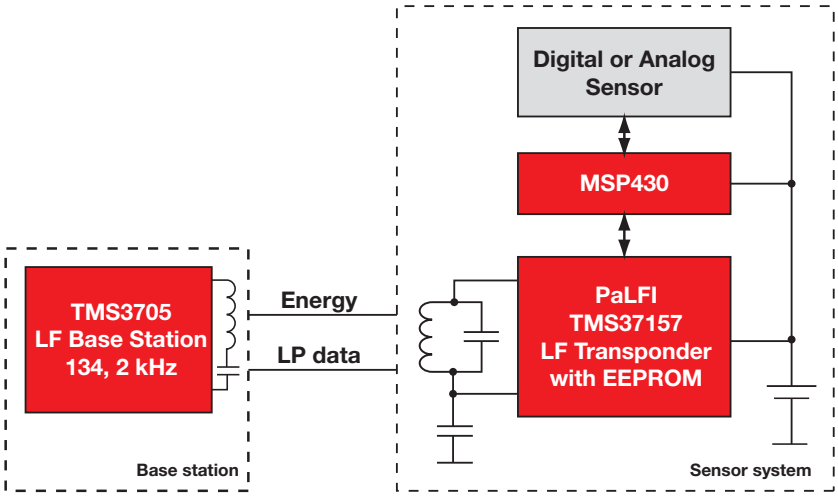
PaLFI – Passive Low-Frequency Interface Device
TMS37157

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/TMS37157**

The PaLFI – Passive Low-Frequency Interface TMS37157 enables short-range two way communication without the need of a battery by harvesting the RF energy transmitted from the base-station. It combines a Low-Frequency RFID Transponder with EEPROM memory and an SPI Interface to connect to a microcontroller. The EEPROM memory is accessible via the LF and SPI interface without battery support. It is ideal for data-logging applications (configuration or updating a device without the need of a battery), for medical applications (non-battery operated bio-sensors) and as a method for recharging batteries while enabling two way communications. The TMS37157 can also be used in combination with active low power devices to wake up the active device in a defined read zone and thus conserve the battery life. Dependent on system parameters such as antenna sizes and base station power, the device wirelessly powers an MSP430 MCU at ranges up to 1.5 meter.

Key features

- Low frequency half duplex (HDX) interface
  - Special selective addressing mode allows anti collision
  - Up to 8 kbit/s LF uplink data rate
- 3-wire SPI interface
- 1008 bit EEPROM:
  - 968-bit free available EEPROM user memory
  - 32-bit unique serial number
  - 8-bit selective address
  - Pages are irreversible lockable and protectable
- Power management for connected microcontroller



TMS37157 block diagram.

Benefits

- Batteryless operation of a microcontroller supplied by RF field
- EEPROM memory expansion for microcontroller
- Dedicated LF wake-up
- HDX transponder communication
- Battery check and battery charge function

Applications

- Wireless batteryless interface
  - Medical
  - Metering
- LF wake-up for container tracking
- Configuration memory (end of production line)

Development tools and software

- ez430-TMS37157 evaluation kit

PaLFI – Passive Low-Frequency Interface

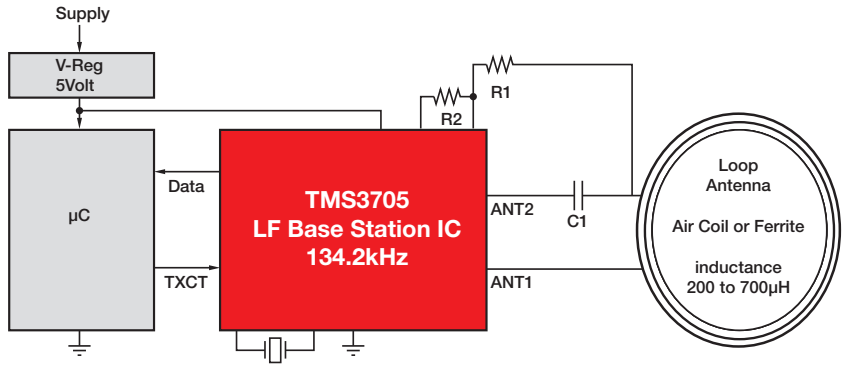
Part number	TMS37157
Communication interfaces	SPI, RFID, direct microcontroller access via RFID
Operating frequency	134.2kHz
Wired communication interface	3-wire SPI
Operating voltage	2V to 3.6VDC
Current consumption	Active mode max 150µA
	Power-down mode 60nA
Battery charge current	Max 2mA
Memory	32-bit unique serial number
	968-bit EEPROM user memory
	8-bit selective address
Operating temperature	–40˚C to +85˚C
Storage temperature	–40˚C to +125˚C
Package	16-pin VQFN (4mm × 4mm)
Packing/delivery	Tape-on reel, 3,000 per reel

TMS3705

134.2-kHz Transceiver IC
TMS3705

Get samples, evaluation modules and application notes at: **www.ti.com/sc/device/TMS3705**

The TMS3705 is a highly integrated transceiver IC to support all HDX transponders and TI LF dual interface devices. This base station IC drives the antenna of a transponder system to send data modulated on the antenna signal, and to detect and demodulate the response from the transponder. It allows efficient development and enables minimizing the external component count for RFID reader systems.



TMS3705 block diagram.

Key features
- Transceiver IC for 134.2 kHz Transponder and PaLFI – Passive Low Frequency Interface Device
- HDX transmission principle
- Digital FM/FSK demodulator
- Asynchronous or synchronous data interface to µC
- Automatic transponder frequency measurement and adaptation
- Integrated diagnosis functions
- Full bridge antenna driver
- Built-in band-pass filter and limiter
- Short-circuit protection
- Power-on reset
- PLL for internal clock generation
- Sleep-mode current consumption: typ. 15 µA
- Designed for automotive requirements
- 16-pin SOIC (D) package

Benefits
- 2-wire interface
- Low external component count
- Remote antenna principle (up to 10m)

Applications
- 134.2kHz Reader (HDX) for:
  - Automotive immobilizer
  - Animal ID
  - Access control
  - Industrial automation
  - Container tracking
  - Asset management

Development tools and software
- Included in ez430-TMS37157 Evaluation Kit

For more information on transponders and inlays please visit

www.ti.com/lf-transponders

Part number	TMS3705
Operating frequency	134.2 kHz
Communication interface	SCI Asyn/Sync
Supply voltage	4.5 V to 5.5 VDC
Current consumption	RX 8 mA TX 220 mA peak Sleep Mode 15 µA
Transmitter modulation	100% ASK
Demodulation format	FM/FSK
FSK data rate	8kbps
Transmission principle	HDX
Operating temperature	–40˚C to +85˚C
Storage temperature	–55˚C to +150˚C
Package	16-pin SOIC-D
Packing/delivery	Tape-on Reel, 2500 per reel

TRF796x

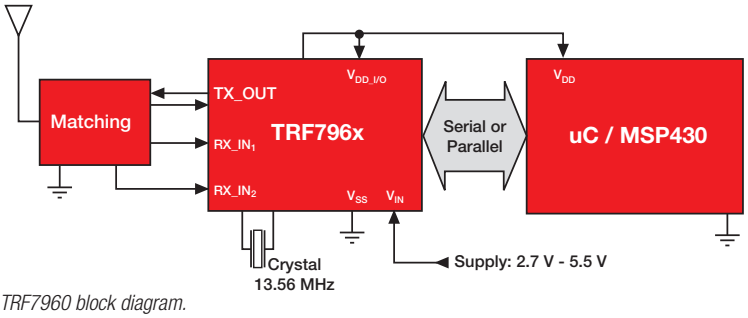
13.56-MHz Reader/Writer Transceiver ICs
TRF7960, TRF7960A, TRF7961, TRF7962A, TRF7963A, TRF7964A

Get samples, evaluation modules and application notes at: **www.ti.com/nfc**

The TRF796x is a pin compatible, high performance 13.56-MHz HF RFID Reader IC family comprising an integrated analog front end (AFE) and a built in data-framing system for ISO/IEC 15693, ISO/IEC 18000-3, ISO/IEC 14443A and B. This includes data rates up to 848kbits for ISO/IEC 14443 with all framing and synchronization tasks on board. This architecture enables the customer to build a complete reader using only a low end microcontroller. Other standards and even custom protocols can be implemented by using the various Direct Modes of the device. The Direct Modes allow the user to get access to the Sub-Carrier Data or to the unframed, however already ISO Formatted Data stream. A parallel or serial interface (SPI) can be used for the communication between the Microcontroller and the TRF796x. The transmitter has selectable output-power levels of 100mW (+20dBm) or 200mW (+23dBm) equivalent into a 50 Ohm load when using a 5V supply. The receiver system enables AM and PM demodulation using a dual-input architecture to minimize communication holes. The reader is configured by selecting the desired protocol in the control registers. Direct access to all control registers allows fine tuning of various reader parameters as needed.

Key features

- ISO 14443A/B, ISO 15693, FeliCa, Mifare
- Supply voltage range: 2.7 – 5.5 V
- Parallel data communication or serial 4-pin SPI interface
- Integrated data framing, CRC and/or parity checking
- Multiple sub-carrier receiving and decoding compatibility
- Data rates supported up to 848 kHz
- Integrated voltage regulators for MCU supply (20 mA)
- Clock output for MCU
- Selectable receive gain with AGC
- Antenna driver using OOK or ASK modulation
- Programmable output power, 100 mW and 200 mW
- 7 user selectable power modes



TRF7960 block diagram.

Benefits

- Easy to use with high flexibility
- Completely integrated protocol handling
- Auto-configured default modes for each supported ISO protocol
- Separate internal high-PSRR power supplies for analog, digital, and PA sections provide noise isolation for superior read range and reliability
- Dual receiver inputs with AM and PM demodulation to minimize communication holes
- Receiver AM and PM RSSI
- High integration reduces total BOM and board area
- Ultra-low-power modes
- Power down < 1 µA
- Standby 120 µA

Applications

- 13.56-MHz RFID reader
- Access control
- POS contactless payment
- Prepaid eMetering
- Medical equipment
- Product identification/authorization (consumables)

Development tools and software

- TRF7960AEVM – Evaluation Kit
- TRF7960ATB target board for MSP-EXP430F5438A board, ARM® Cortex®-M3 based DK-LM3S9BD96 board, or any other TI embedded microcontroller platform with the EM socket headers populated.

For more information on transponders and inlays please visit *www.ti.com/hf-transponders*

General Characteristics

Part Number	TRF7960 TRF7960A TRF7964A	TRF7961 TRF7962A	TRF7963A
Operating frequency	13.56 MHz		
Supported protocols	ISO/IEC 15693, ISO/IEC 18000-3 ISO/IEC 14443A ISO/IEC 14443B	ISO/IEC 15693, ISO/IEC 18000-3	ISO/IEC 14443A ISO/IEC 14443B
Operating voltage	2.7 to 5.5 VDC		
Current consumption	Transmit: 200 mW at 120 mA, typ. 100 mW at 70 mA, typ. Active (RX only): 10 mA, typ. Stand-by: 120 µA Power down: <1 µA		
Transmitter power	Adjustable power, 100 mW or 200 mW at 5 VDC		
Transmitter modulation	ASK, adjustable 8% to 30% OOK		
Communication interface	Parallel 8-bit or 4-wire SPI		
Operating temperature	–40°C to +110°C		
Storage temperature	–55°C to +150°C		
Package	32-pin QFN, (5 mm × 5 mm)		
Packing/delivery	Tape-on Reel, 250 or 3000 per reel		

TRF7970A

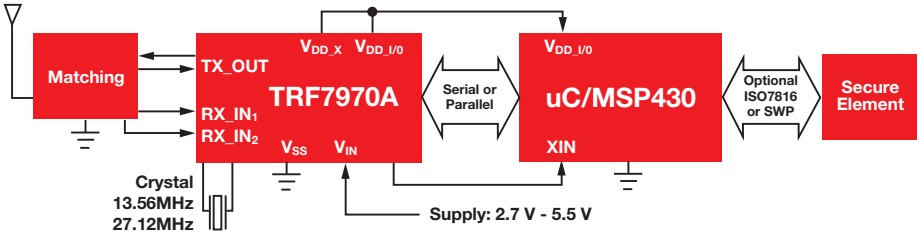
13.56-MHz NFC (Near Field Communication)/RFID Transceiver IC
TRF7970A

Get samples, evaluation modules and application notes at: **www.ti.com/nfc**

The TRF7970A is the newest addition to the TRF796x HF Transceiver IC Family. TRF7970A supports Near Field Communication (NFC) Standards NFCIP-1 (ISO/IEC 18092) and NFCIP-2 (ISO/IEC 21481) which defines the selection of any of the four possible communication modes (NFC peer-to-peer, card emulation, proximity reader/writer – ISO 14443A/B, Mifare or FeliCa and Vicinity reader/writer – ISO 15693). Integrated encode, decode and data framing capability for data rates up to 848bps, wide supply voltage range support (2.7V – 5.5V), large FIFO buffer for RF communication, relevant NFC software stack libraries and an innovative RF field detector allow for easy development efforts and robust, cost effective designs. Finally, eight selectable power modes and ultra-low power operation enable the longest battery life in the industry. The devices also offer unparalleled flexibility via the various direct communication modes on the device to allow implementations of custom protocols as well as other 13.56-MHz standards. The receiver system enables AM and PM demodulation using a dual-input architecture to maximize communication robustness.

Key features

- NFCIP-1, NFCIP-2
- Peer-to-peer, card emulation, reader/writer functionality
- ISO 14443A, ISO 14443B, FeliCa, ISO 15693
- Supply voltage range: 2.7 – 5.5V
- Operating temperature: –40°C to +110°C
- Parallel or SPI interface
- Integrated data framing, CRC and/or parity checking
- Integrated voltage regulators for MCU supply (20 mA)
- Clock output for MCU
- Selectable receive gain with AGC
- Antenna driver using OOK or ASK modulation
- Programmable output power, 100 mW and 200 mW
- RF field detector with programmable wake-up levels
- Eight user-selectable power modes 100 mW and 200 mW
- 7 user-selectable power modes



TRF7970A block diagram.

Benefits

- Easy to use with high flexibility
- Completely integrated protocol handling
- Auto-configured default modes for each supported ISO protocol
- Separate internal high-PSRR power supplies for analog, digital, and PA sections provide noise isolation for superior read range and reliability
- Dual receiver inputs with AM and PM demodulation to minimize communication holes
- Receiver AM and PM RSSI
- High integration reduces total BOM and board area
- Ultra-low-power modes
- Power down < 1 µA
- Standby 120 µA

General Characteristics

Part Number	TRF7970A
Operating frequency	13.56 MHz
Operating Modes	**Reader/Writer** ISO/IEC 15693, ISO/IEC 18000-3 ISO/IEC 14443A ISO/IEC 14443B **Peer-to-peer** ISO 18092 / NFCIP-1 **Card Emulation** ISO 14443A & B
Operating voltage	2.7 V to 5.5 VDC
Current consumption	Transmit: 200 mW at 120 mA, typ. 100 mW at 70 mA, typ. Power down: <1 µA
Transmitter power	Adjustable power, 100 mW or 200 mW at 5 VDC
Transmitter modulation	ASK, adjustable 8% to 30% OOK
Communication interface	Parallel 8-bit or 4-wire SPI
Operating temperature	–40°C to +110°C
Storage temperature	–55°C to +150°C
Package	32-pin QFN, (5 mm × 5 mm)
Packing/delivery	Tape-on Reel, 250 or 3000 per reel

Applications

Infrastructure devices which communicate to the NFC enabled smart phones and PDAs:

- Public transport/event ticketing
- Access control/digital door-lock
- POS contactless payment
- Medical equipment
- Product identification/authentication
- Sharing of electronic business cards
- Secure pairing
  - *Bluetooth*, wireless networks
- Short range wireless communication
  - Firmware updates

Development tools and software

- TRF7970AEVM evaluation kit
- TRF7970ATB target board for MSP-EXP430F5529 board or any other TI embedded microcontroller platform with the EM socket headers populated

Embedded Processors

TI Embedded Processors – A perfect companion to our radios in wireless systems

Microcontrollers are an integral part of all wireless connectivity systems, especially in low-power wireless solutions. From being the main applications and/or protocol processor to performing power management functions to coordinating communications, microcontrollers play a key role both in battery operated end nodes as well as host devices such as coordinators and routers. TI's broad industry leading portfolio of embedded processors, from the ultra-low power MSP430™ microcontrollers to our high-performance Sitara™ portfolio and DSP products, ensures you have the choice of the right device for any wireless connectivity application.

TI recognizes the importance of embedded software in wireless connectivity solutions. Our embedded processors are supported by a wide variety of software stacks, including protocol and network solutions.

Finally we offer a comprehensive suite of development tools and online resources to make your wireless connectivity design robust, easy and fast.

Embedded Processing Portfolio

TI Embedded Processors

Code Composer Studio™ IDE

Microcontroller (MCU)			ARM®-Based Processor		Digital Signal Processor (DSP)	
16-Bit Ultra-Low Power MCUs	**32-Bit Real-Time MCUs**	**32-Bit ARM MCUs**	**32-Bit ARM Safety MCUs**	**32-Bit ARM Processors**	**Singlecore DSPs**	**Multicore Processors**
MSP430™	**C2000™**	**Tiva™ C Series** ARM Cortex™-M4	**Hercules™** ARM Cortex-R4F	**Sitara™** ARM Cortex-A9, -A8, -ARM9	**C5000™ C6000™**	**C6000™ DSP** and ARM Cortex-A15
• Up to 25 MHz • Up to 512 KB Flash • Up to 64 KB FRAM • Analog I/O, ADC • LCD, USB, RF	• 40 MHz to 300 MHz • Flash, RAM 16 KB to 512 KB • PWM, ADC, CAN, SPI, I²C	• Up to 80 MHz • Flash 32 KB to 256 KB • USB OTG, CAN, ADC, PWM, SPI	• Up to 220 MHz • Flash 256 KB to 3 MB • USB, ENET, FlexRay™,Timer/ PWM, ADC, CAN, LIN, SPI, I²C, EMIF	• Up to 1 GHz • Up to 32 KB I/D Cache, 256 KB L2, LPDDR1/2, DDR2/3 support • GEMAC, CAN SATA+PHY, USB+PHY, PRU-ICSS camera	• Up to 800-MHz DSPs, SDRAM, DDR2, µPP, I²C, I²S, UHPI, McASP/ McBSP, LCDC, Integrated connectivity options: USB 2.0, EMAC • GEMAC, PCIe+PHY, SATA+PHY, CAN, USB+PHY, PR-ICSS	• Up to 10-GHz Multicore, Fixed/Floating+ accessories • Up to 4 MB SL2, 32 KB L1, 1 MB L2 • RapidIO®, PCIe, McBSP, 10/100 MAC, µPP, UART, HyperLink, DDR2/3
Measurement, Sensing, General purpose	Motor control, Digital power, Lighting, Renewable energy	Connectivity, Security, Motion control, HMI, Industrial automation	Safety, Transportation, Industrial and medical	Consumer, Industrial, Connected home, POS, Smart grid, Medical	Patient monitoring, Biometric security, Smart e-meter, Industrial drives	Telecom, Medical, Mission critical, Base stations

MSP430™ Microcontrollers

The MSP430 family of ultra-low-power microcontrollers

MSP430 microcontrollers (MCUs) from Texas Instruments (TI) are 16-bit, RISC-based, mixed-signal processors designed for ultra-low power. Our MCUs offer the lowest power consumption and the perfect mix of integrated peripherals for thousands of applications – including yours. We also provide all of the hardware and software tools you need to get started today! Not only that, TI has a plethora of complementary components to meet your needs. Learn more today at ti.com/msp430. Visit *www.ti.com/msp430* for a complete product portfolio and more information.

By making RF design easy, performance-rich and power-efficient, the MSP430 helps advance RF networking applications from RFID to *Bluetooth*®/*Bluetooth* low energy as well as proprietary protocols. These applications include, but are not limited to, industrial/building automation, asset tracking, industrial monitoring and tamper detection, alarm and security systems, sports/body monitoring, wireless keyboard/mouse products, wireless gaming accessories and automatic metering infrastructure (AMI). The ultra-low power consumption of the MSP430 also enables energy harvesting applications with wireless systems.

www.ti.com/embeddedrf

MSP430 – your ultra-low-power wireless connectivity microcontroller

Ultra-Low Power

Battery life > 20 years
- <100 µA/MHz
- 0.1µA RAM retention
- <1µA RTC mode

More performance without sacrificing battery life
- 7 low-power modes
- Instant wakeup
- Autonomous peripherals

Integration

Advanced peripherals
- High-performance analog
- Optimized serial communications
- Operate in low-power modes

Minimize physical footprint and bill of materials
- USB
- LCD drivers
- Sigma-Delta ADCs

Ease of Use

Development
- Start with MSP430 LaunchPad Evaluation Kit
- Comprehensive software portfolio
- Application-specific ecosystem

Support
- Code examples
- Direct support available at **ti.com/e2e-msp430**
- Developer community at **43oh.com**

Grow with MSP

Scale your applications
- 400+ devices
- Up to 512 KB Flash and 64 KB RAM
- 25+ package options

Unlimited possibilities with TI
- Data collection
- Wireless connectivity
- Power solutions

MSP430 embedded software:

The MSP430 microcontroller supports several wireless connectivity protocol and networking software stacks with more options coming soon.

Stack	MSP430 device	Availability
SimpliciTI	MSP430F2xx, MPR430F5xx, MSP430F4xx, CC430Fxx, MSP430FR57xx	For more information, visit ti.com/embeddedrf
TIMAC 802.15.4	MSP430F461x*, MSP430FR57xx	For more information, visit ti.com/embeddedrf
ZigBee Coordinator	MSP430F227x*, MSP430F461x*, MSP430F54xxA*	For more information, visit ti.com/embeddedrf
ZigBee End Device	MSP430F227x*, MSP430F461x*, MSP430F54xxA*, MSP430FR57xx	For more information, visit ti.com/embeddedrf
Bluetooth v2.1 + EDR, SPP	MSP430BT5190*, MSP430F5529	For more information, visit ti.com/embeddedrf
6LoWPAN	CC430Fxxx*, MSP430F5438A	For more information, visit ti.com/embeddedrf
Dash7	CC430Fxxx*	For more information, visit ti.com/embeddedrf

*Can be ported to other MSP430 MCU devices (depending on memory requirements)

MSP430™ Microcontrollers

Hardware

Now, let's talk hardware! MSP430 MCUs are supported by a broad collection of hardware development tools for beginners as well as experienced engineers. Our tools range from low-cost development kits like the MSP430 LaunchPad Evaluation Kit to highly-integrated, application-specific platforms and target boards for integrating MSP430 into your designs.

MSP430 LaunchPad and BoosterPack ecosystem

LaunchPad Evaluation Kits provide customers everything needed to get started.

Try it out with Energia for the simplified user experience! Learn more about this easy-to-use IDE at *www.energia.nu/*

BoosterPacks are plug-in modules for the LaunchPad, which enable customers to stack additional functionality such as wireless, capacitive touch and more.

Explore the ecosystem at *www.ti.com/launchpad*

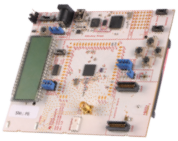
MSP-EXP430F5529LP
connected to the CC3000-BOOST

Full-featured development kits

eZ430-CHRONOS
CC430-based RF wireless development kit in a sports watch form factor in 433, 868 and 915 MHz frequencies

MSP-EXP430FG4618
Featuring MSP430FG4618 and MSP430F2013 on-board segmented display, buzzer, RS-232, capacitive touch, microphone, RF headers, JTAG

MSP-EXP430F5529
Featuring MSP430F5529 complete USB development platform, on-board dot matrix display, JTAG, RF headers, on-board emulation, accelerometer, microSD, capacitive touch

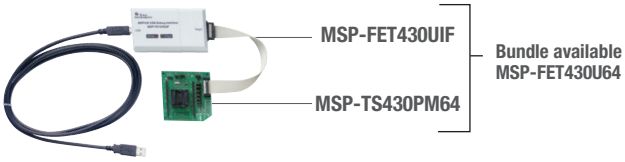


MSP-EXPCC430RF
Featuring CC430F6137 and CC430F5137 on-board emulation, segmented LCD, light sensor, includes F6137-based motherboard and F5137-based satellite board

Hardware support tools

One tool to rule them all.

The MSP430 Flash Emulation Tool (MSP-FET430UIF) supports all MSP430 devices when paired with the appropriate target board.



Production programmer

The MSP-GANG can program up to eight identical MSP430 Flash or FRAM devices at the same time and allows the user to fully customize the process.

We're here for you!

- Reference designs available for many applications
- Direct support through our E2E™ Forum at *www.ti.com/e2e-msp430*

Learn more at *www.ti.com/msp430tools*

MSP430™ Microcontrollers

Wireless connectivity hardware tools from MSP430:

The MSP430 eZ430 development tools are the best way to get familiar with the MSP430 MCU and include all the software and hardware needed to develop a complete project and are available for as little as $20. Most eZ430 tools include a programming interface that provides full debugging and programming capabilities for the detachable MSP430 target boards. For more information visit *www.ti.com/ez430.*

Part Number	CC3000-FRAM-EMK	eZ430-Chronos	eZ430-RF2500	eZ430-RF2500-SEH	eZ430-TMS37157	eZ430-RF256x
Key Feature	Full turn-key TI Wi-Fi evaluation and demonstration tool for the MSP430 FRAM MCUs and TI's SimpleLink™ Wi-Fi	Sub-1-GHz wireless watch with integrated sensors	2.4-GHz wireless connectivity development board	Solar Energy Harvester with 2.4 GHz connectivity	Passive low frequency RFID connectivity	*Bluetooth*® connectivity

*Can be ported to other MSP430 MCU devices (depending on memory requirements)

Experimenter Board kits:

These innovative kits feature select MSP430 devices and include additional hardware components to take advantage of the high level of analog integration available for easy system evaluation and prototyping. These kits are ideal for learning the MSP430 architecture, testing the capabilities of available peripherals and include integrated headers for plugging in low-power RF modules (CCxxxxEMK).

Part Number	MSP-EXP430F5438	EM430F6137RF900	MSP-EXP430F5529	MSP-EXP430FR5739	EM430F6147RF900	MSP-SA430-SUB1GHZ
Key features	Dot matrix grayscale display, microphone, audio output, RF expansion connector, USB connectivity, accelerometer, joystick	EM430F6137RF900	5-pad capacitive touch strip, microSD card slot with 1GB card, USB connectivity, supports	Integrated MSP430FR5739 3-axis accelerometer NTC thermister 8 display LEDs Footprint for additional through-hole LDR sensor 2 user-input switches	Sub-1-GHz CC430 complete wireless development tool kit. Includes DC-DC converter option for lower power operation	Low-cost sub-GHz spectrum analyzer Supported frequency ranges: 300–348 MHz, 389–464 MHz, 779–928 MHz Open source QT-based Graphical user interface
Supports	Any CCxxxxEMK module, PAN1323EMK, CC2567PAN1327ANTBT, CC3000		Most wireless daughter cards (CCxxxx RF). CC1101EMK, CC2500EMK, CC2430EMK, CC2530EMK, CC4000GPSEM, CC3000	Connection to most wireless daughter cards (CCxxxx RF), User experience, Preloaded with out-of-box demo code, 4 modes to test FRAM	CC430 SoCs	CC110x transceivers, CC430 SoS, CC111x SoC

*Can be ported to other MSP430 MCU devices (depending on memory requirements)

Sitara™ Processors

TI's Sitara processors based on the ARM9™ and ARM® Cortex®-A8/-A9 cores, in conjunction with TI's Wi-Fi®/*Bluetooth*® connectivity options provide the right combination of performance, power and peripherals to meet any wireless application need. Drive down system cost, simplify design and expand connectivity of your current design all while maintaining software compatibility across TI's ARM9 and ARM Cortex-A8/-A9 processor portfolio.

Key features

- Multiple operating frequencies for optimizing power vs. performance
- 3D graphics acceleration, multiple packaging options and temperature ranges
- TI connectivity solutions (Wi-Fi/*Bluetooth*) support
- High-bandwidth connectivity peripherals such as Gigabit Ethernet, DDR2/DDR3 interfaces, CAN, SATA 2.0 and USB 2.0

Applications

- Portable data terminals
- Connected audio
- Point-of-sale
- Connected displays
- Consumer goods
- Industrial automation
- Portable navigation
- Medical
- Gaming equipment

Performance

- **Up to 1-GHz ARM Cortex-A8 and -A9**
- **Graphics acceleration up to 27M polygons per second**
- **High-speed DDR2 and DDR3 memory performance**
- **Dual- and quad-core PRU-ICSS for deterministic, real-time performance**

Portfolio

- **Leverage TI's extensive portfolio of embedded ARM devices to maximize your product's changing needs**
- **Reuse of both software and hardware design across portfolio**
- **Fully pin-for-pin and software-compatible options across portfolio**

Performance

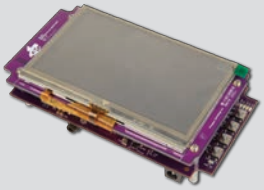
- **Wi-Fi/*Bluetooth***
- **Gigabit Ethernet**
- **SATA, CAN 2.0 and high-speed USB interface**
- **Multiple serial ports**
- **Touch-screen LCD controllers**
- **Industrial peripheral support**

Ease of Use

- **Free and easy access Linux™ and Android™**
- **Application-specific and advanced development kits**
- **Third-party RTOS ecosystem**

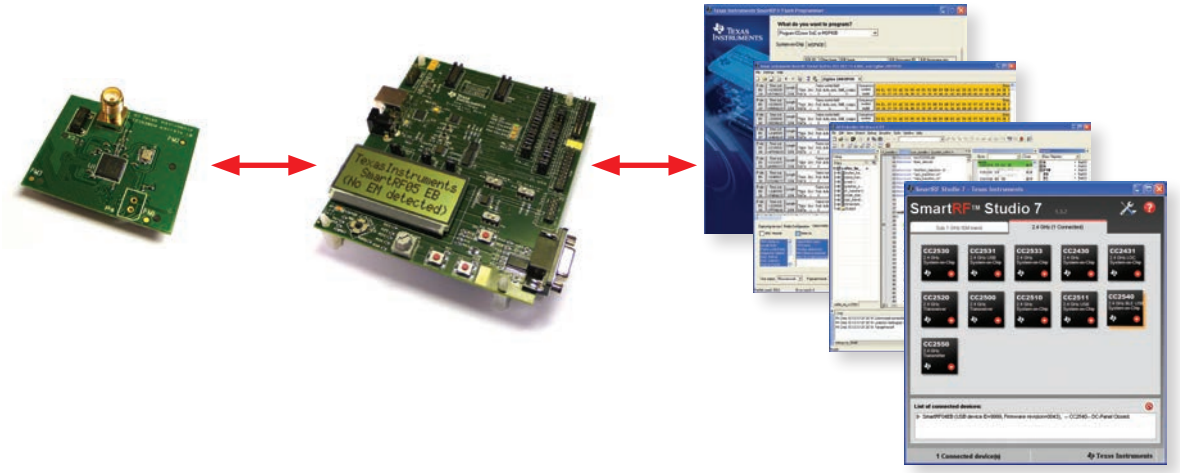
Development tools

These full-featured development boards come complete with hardware, software and documentation and a wireless connectivity module to accelerate hardware/software development. Available from TI and distributors. Additional low-cost community-based boards can be obtained from numerous partners and distributors. *www.ti.com/sitara*

			
Part Number	BeagleBone Black – BEAGLEBK	AM335x Starter Kit – TMDSSK3358	AM437x EVM – TMDXEVM437X
Description	Low-cost, open-source community platform with plug-in board expansion	Low-cost with optimized BOM and DDR3 and LCD	Evaluate functionality of AM4379/4378/4377/4376 processors with Gigabit Ethernet, 7" capacitive touch LCD screen, 2 camera modules and connector to WiLink™ 8

Development Tools

TI provides development tools that enable both software and hardware designers to quickly get up and running with wireless connectivity products. The general-purpose low-power RF development tools consist of three elements – the Evaluation Module, Evaluation Board and PC Tools:



Evaluation Module (EM)
A small plug-in board with the complete reference design for the radio device, ensuring maximum performance.

Evaluation Board (EB)
Contains sockets for the EM. Platform for testing the performance of the radio and for development of protoype software.

PC Tools
Connect the EB to the PC and use available tools to test, configure and debug software running on the chip.

There are several types of hardware development tools.

Development Kit (DK)

The DK contains all the hardware that is necessary to start development of an RF system. In most configurations, a development kit consists of two Evaluation Boards, two small RF modules, antennas and cables.

Mini Development Kit (DK-MINI)

Mini Development Kits are low-cost development kits that contain the basic hardware for prototyping and for developing simple demonstration applications. The kits can also be used for basic evaluation of the device.

Evaluation Module Kit (EMK)

The EMK contains two RF modules (EM) and antennas. The EMK can be ordered separately and can be used as add-ons to existing kits, compatible motherboards or other boards with matching connectors.

USB Dongles

Small form-factor dongles with the USB enabled System-on-Chip (SoC) and PCB antenna.

ZigBee® and ZigBee RF4CE Development Kits

The ZigBee Development Kit (ZDK) has all the features of a development kit, but contains additional nodes for experimenting with the mesh capabilities of ZigBee. The kit is preprogrammed with a ZigBee demo application, giving you ZigBee directly out of the box.

A specific ZigBee Network Processor (ZNP) kit demonstrates the concept with a CC2530 running the Z-Stack and a small MSP430 running the application code.

To get quickly up and running with ZigBee RF4CE, there's a dedicated kit containing a fully functional remote controller, a receiver board with a multitude of connection options and a USB dongle for PC connectivity.

Bluetooth low energy Development Kits

TI has made it easy for a fast and convenient development with *Bluetooth* Low Energy by the use of the CC2540DK-MINI. It contains a USB dongle and a key fob for rapid prototyping. Complete Evaluation Module Kits for CC2540 and CC2541 are also available.

Bluetooth low energy SensorTag Development Kit

The award-winning SensorTag development kit, based on the CC2541 SoC, shortens the design time for *Bluetooth* application development from months to hours with no hardware or software expertise required. The over-the-air download feature provides the ability to update firmware from a central device like a smartphone, tablet or PC. The SensorTag has limitless possibilities in applications including health and fitness, educational tools, toys, remote controls and mobile phone accessories. Find out more at *ti.com/tool/cc2541dk-sensor*.

Development Tools

Device	Device Type	Development Kits	Evaluation Module Kits (Add-on boards)	Other Compatible Mother Boards
CC1101	Transceiver sub-1 GHz	CC1101DK433 CC1101DK868-915	CC1101EMK433 CC1101EMK868-915	MSP430FG4618 Exp Board MSP430F5438 Exp Board
CC110L CC113L CC115L	Value line transceiver, Receiver and transmitter	CC11xLDK868-915	CC11xLEMK-433	
CC1101-Q1 CC1131-Q1 CC1151-Q1	Automotive qualified transceiver Automotive qualified receiver Automotive qualified transmitter sub-1 GHz	CC1101DK-433 MHz CC1101DK-868/915 MHz		
CC1120	High-performance RF transceiver for narrowband systems	CC1120DK	CC1120EMK169 CC1120EMK420-470 CC1120EMK868-915 CC1120EMK955	
CC1121	High-performance low-power RF transceiver		CC1121EMK868-915	
CC1175	High-performance RF transmitter for narrowband systems		CC1175EMK868-915	
CC1110 CC1111	8051-based System on Chip sub-1 GHz	CC1110DK-MINI-868 CC1110-CC1111DK	CC1110EMK433 CC1110EMK868-915 CC1111EMK868-915 (USB dongle)	
CC430	Integrated MSP430 and CC1101 System on Chip	EZ430-Chronos Wireless Watch EM430F6137RF900 EM430F6147RF900 MSP-SA430-SUB1GHZ		
CC1190	PA and LNA front end sub-1 GHz		CC1101CC1190EMK868 CC1101CC1190EMK915	
CC2500	Transceiver 2.4 GHz	CC2500-CC2550DK	CC2500EMK	MSP430FG4618 Exp Board MSP430F5438 Exp Board
CC2510 CC2511	8051-based System on Chip 2.4 GHz	CC2510DK-MINI CC2510-CC2511DK	CC2510EMK CC2511EMK (USB dongle)	
CC3100 CC3200	Wi-Fi® device, modules	CC3100BOOST CC3200-LAUNCHXL	*CC3100 BoosterPack* *CC3200 LaunchPad*	CC3100BOOST - MSP-EXP430F5529LP CC3100BOOST - EK-TM4C123GXL CC3200-LAUNCHXL - Camera BoosterPack, Audio BoosterPack
CC4000	GPS module	CC4000GPSEM	CC4000-TC6000GN	MSP-EXP430F5529
C2520	Transceiver – IEEE 802.15.4, ZigBee® PRO	CC2520DK	CC2520EMK	MSP430F5438 Exp Board
C2530	8051-based System on Chip	CC2530DK	CC2530EMK	
CC2531	IEEE 802.15.4, ZigBee PRO	Only for CC2530	CC2531EMK (USB Dongle)	
CC2533	8051-based System on Chip IEEE 802.15.4, ZigBee RF4CE	CC2533DK CC2533DK-RF4CE-BA	CC2533EMK	
CC2540 CC2541	8051-based System on Chip *Bluetooth*® low energy	CC2540DK-MINI CC2540DK	CC2540EMK CC2540EMK-USB (USB dongle), CC2541EMK	
CC2543/2544/2545	8051-based System-on-Chip	CC2543-CC2544DK	CC2545EMK	
CC2560	*Bluetooth* v2.1 + EDR module	EZ430-RF256x	CC256xQFNEM	DK-TM4C123G See *www.ti.com/bluetooth*
CC2564	*Bluetooth* v2.1 + EDR, *Bluetooth* v4.0 and ANT™ dual-mode	CC256x BTBLE-Kit	CC256xQFNEM	DK-TM4C123G See *www.ti.com/bluetooth*
CC257x	ANT network processor	ANTC7EK1 (CC257x)		
CC2590 CC2591	PA and LNA front end 2.4 GHz		CC2520-CC2591EMK CC2530-CC2591EMK	
CC2595	PA front end 2.4 GHz		CC2595EMK	
CC85xx	PurePath™ wireless audio	CC85xxDK CC85xxDK-HEADSET		
TMS37157 TMS3705	Passive low-frequency interface device 134.2kHz transceiver IC	ez430-TMS37157		
TRF796x	13.56 MHz transceiver IC	TRF7960EVM	TRF7960ATB	
TRF7970A	13.56 MHz NFC transceiver IC	TRF7970AEVM	TRF7970ATB	MSP-EXP430F5438, MSP-EXP430F5529
WiLink™ 8 modules	Wi-Fi module		WL1835MODCOM8 WL1835MOD Cape	Sitara™ AM335x EVM BeagleBone open source computer

Development Tools

Other Development Kits

Tool Name	Short Description
SOC-BB	General purpose battery board for LPRF EM modules. The board has EM connector sockets, break-out pins, battery holders for two AA batteries, a LED and a button.
CC-ANTENNA-DK	The Antenna Evaluation Kit can be used as a reference for various antenna designs and for testing the performance that can be achieved. This kit contains an A4-sized PCB panel with 16 different boards; 13 antenna designs and 3 boards for calibration purposes. The frequency range of the antennas is from 136 MHz to 2480 MHz.
CC-DEBUGGER	Low-cost debugger probe and programming tool for CCxxxx 8051-based System-on-Chip (SoC) and for programming of devices in the CC85xx family. Can be used together with SmartRF Studio, SmartRF Flash Programmer, PurePath Wireless Configurator and IAR Embedded Workbench for 8051.
eZ430-RF2560	Low-cost demonstration and evaluation tool with CC2560 and MSP430BT5190
AM37x / DM37x	WL1271-TiWi (WLAN/*Bluetooth*) connectivity card pre-integrated with AM/DM37x processor evaluation module
AM18x / OMAP-L138	WL1271-TiWi (WLAN/*Bluetooth*) connectivity card pre-integrated with AM18x/OMAP-L138 processor evaluation module
AM335x	WL1271-TypeTN (WLAN/*Bluetooth*) connectivity card pre-integrated with AM335x processor evaluation module
TMDXWL1271COM6M	WL1271-TypeTN (WLAN/*Bluetooth*) connectivity card available as aftermarket DM814x processor evaluation module
430BOOST - CC110L	CC110L BoosterPack for MSP430 LaunchPad
CC1180 - 6LoWPAN - DK868	Complete CC-6LOWPAN-DK-868 system development kit including IPv6 to 6LoWPAN gateway

Related PC Tools

Tool Name	Short Description
SmartRF™ Studio	Application for controlling the RF ICs from the PC and to find appropriate register settings for the radio.
SmartRF Packet Sniffer	Simple packet sniffer application. Communicates with an evaluation board with a radio that captures packets on the specified channel. The sniffer GUI parses and displays the packets.
SmartRF Flash Programmer	Use this application to program hex files on the system on chips or to update the firmware on the evaluation boards.
PurePath™ Wireless Configurator	Use this graphical PC tool for configuring and programming of CC85xx devices
PurePath Wireless Commander	Run tests for evaluating performances of CC85xx devices
Bluetooth Hardware Evaluation Tool	Tool used to configure the BT chip's properties through the Service Pack (SP) and also allows to test RF performance

TI University Program offers universities the industry's broadest wireless connectivity portfolio, supporting more than a dozen different wireless technologies.

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www.ti.com/univcontacts

TI university program
technology for tomorrow's innovators
www.ti.com/university

engineeringchange™

Development Tools

Frequently Asked Questions

What can I do with a DK?

In most configurations, a development kit consists of two Evaluation Boards, two small RF modules, antennas and cables. When the RF modules are connected to the Evaluation Board, it is possible to control the radio from the PC using SmartRF™ Studio. Most of the development kits also come preprogrammed with a Packet Error Rate test application, which makes it easy to perform practical range testing with the radios. In addition, the development kits are flexible platforms and it is easy to connect your own peripherals and controllers to break-out pins on the boards. The development kit would also serve as a known good platform during test and verification of your own system. For development kits with system-on-chips (SoC), the evaluation boards make it possible to debug and program the chip with no additional hardware. The kit also gives access to useful user interfaces for testing of the various peripherals and capabilities of the SoC. The hardware in the kit can also be used as a packet sniffer.

What is the purpose of the EMK?

The Evaluation Module (EM) is exactly the same piece of hardware that is being used in characterization of the radio, and you will get datasheet performance from these boards. The EMK can be ordered separately and can be used as add-ons to existing kits, compatible motherboards or other boards with matching connectors. The modules are equipped with two 2×10 sockets from Samtec (SFM-110-02-SM-D-A-K-TR) matched with headers from Samtec (TFM-110-02-SM-D-A-K-TR).

Why do I need the Evaluation Board?

The Evaluation Board (EB) is a flexible test and development platform. It makes it easy to perform basic functional RF tests. For example:

- Connect the EB to your hardware to test your own RF design (running tests from SmartRF Studio)
- Use SmartRF Studio + EB + EM to send packets that are received by your own system
- Use your own system to send packets and receive the packets using SmartRF Studio + EB + EM

Thus, you can easily verify the behavior of either your own software or your own hardware, eliminating multiple error sources and reducing the time it takes to debug and test an RF system.

What are MSP430™ Experimenter's Boards?

The MSP430 Experimenter's Boards are versatile development boards for MSP430 with a lot of external peripherals, making it easy to experiment and make prototypes to explore the many features of the MSP430 peripherals. These boards are also equipped with connectors for the RF Evaluation Modules. Note that due to the pin out of the connectors, only a subset of the Evaluation Modules can be used with the boards. You will find schematics, software examples and application notes for the experimenter's boards on the MSP430 development tools web pages.

Are the MSP430 Experimenter's Boards compatible with SmartRF Studio?

No

How do I adopt Wi-Fi®/ *Bluetooth*®?

TI has created platforms which are pre-integrated, fully validated and documented solutions to remove the obstacles of wireless design. Platforms provide complete system integration of all components including Wi-Fi and *Bluetooth* hardware, firmware, low-level drivers, stacks, profiles, and sample source applications. Platforms have also been optimized for reduced system level power consumption and higher throughput. A full suite of detailed user guides, developer guides, datasheets, and extensive FAQs are included.

Where can I go to learn more about Wi-Fi and *Bluetooth* tools?

www.ti.com/connectivitywiki

Why modules?

Customers greatly benefit from validated RF modules which help reduce development time, lower manufacturing costs, improve PCB yield, decrease board space, ease certification, and minimize RF expertise required.

What is the difference between the DK-EM2-2500S and the DK-EM2-2520Z?

The DK-EM2-2500S is a kit tailored to work with the SimpliciTI™ software. It communicates using the CC2500EM but also comes with compatible software for the CC1101 as well as the CC2420. The DK-EM2-2500Z is a kit tailored to work with the ZigBee software. It uses the CC2520 to communicate with two re-programmable CC2530 battery boards.

Software

In addition to the comprehensive hardware portfolio, TI provides a wide range of supporting tools and software stacks:

SimpliciTI™ Network Protocol

www.ti.com/simpliciti

SimpliciTI is a simple low-power RF network protocol aimed at small (<256 nodes) RF networks. Such networks typically contain battery operated devices, which require long battery life, low data rate and low duty cycle. They usually have a limited number of nodes talking directly to each other or through an access point or a range extender. Access points and range extenders are not required, but provide extra functionality such as storing and forwarding messages. With SimpliciTI the MCU resource requirements are minimal which results in a low system cost.

SimpliciTI was designed for easy implementation and out-of-the-box deployment on several TI RF platforms such as the MSP430™ family of low-power MCUs and the CC11xx/CC25xx transceivers and SoCs.

The latest update to SimpliciTI has extended the stack to include auto-acknowledgement, encryption, and dynamic network commissioning/decommissioning features. These additions increase the overall capabilities of SimpliciTI and broaden the scope of applications to which SimpliciTI can be applied. With the flexibility of SimpliciTI to ride on top of many forms of modulation, SimpliciTI is uniquely qualified to work as a basis for extending many existing proprietary formats.

SimpliciTI also supports the narrow band versions of TI's radios in the 2.4-GHz and sub-1-GHz bands.

TIMAC – IEEE 802.15.4 medium access control software stack

www.ti.com/timac

TIMAC is ideal when you need a wireless point-to-point or point-to-multipoint solution based on a standard (e.g., multiple sensors reporting directly to a master).

TIMAC is:

- A standardized wireless protocol for battery powered and/or mains powered nodes
- Support for acknowledgement and retransmission
- Suitable for applications with low data-rate requirements (about 100 kBps effective data rate)
- Support for IEEE 802.15.4-2003
- Support for IEEE 802.15.4-2006
- Multiple platforms
- Easy application development
- Easy porting

TIMAC is distributed as object code free of charge. There are no royalties for using TIMAC.

RemoTI™ – ZigBee® RF4CE/IEEE

www.ti.com/remoti

RemoTI is the industry leading RF4CE-compliant software architecture. Built on TI's well-proven IEEE 802.15.4 compliant TIMAC, RemoTI offers a simple, easy-to-use, intuitive software architectural framework and all of the tools, documentation, and support needed to build an RF4CE compliant product. RemoTI allows you to reduce development time and cost, and enables a quick time to market. RemoTI supports the CC2530, CC2531 and CC2533 platforms.

Z-Stack™ – ZigBee protocol stack

www.ti.com/z-stack

Z-Stack is compliant with the ZigBee 2007 (ZigBee and ZigBee PRO) specification. It is the perfect way to bring the power of mesh network connectivity to any application. Z-Stack supports multiple platforms including the CC2530 System-on-Chip (SoC), CC2531 SoC, CC2520 + MSP430 platform. They are all certified as ZigBee-compliant platforms.

Z-Stack is:

- Robust and reliable (it was one of the first ZigBee stacks to be certified)
- Flexible (it offers APIs at different levels and enable several architectures, including network processor)
- Interoperable (it supports ZigBee Smart Energy and ZigBee Home Automation public profiles)

BLEstack – *Bluetooth*® low energy protocol stack

www.ti.com/blestack

TI's *Bluetooth* low energy (BLE) solution includes all necessary software to get started on the development of single-mode *Bluetooth* low energy applications using the CC2540 system-on-chip. It includes object code with the *Bluetooth* low energy protocol stack, a sample project and applications with source code, and BTool, a Windows PC application for testing *Bluetooth* low energy applications. In addition to the software, the kit contains documentation, including a developer's guide and *Bluetooth* low energy API guide.

Software

Protocol Stack

Name	Description	Web link
SimpliciTI™ Network Protocol	SimpliciTI is a simple low-power RF network protocol aimed at small RF networks	www.ti.com/simpliciti
TIMAC	IEEE 802.15.4 medium access control software stack	www.ti.com/timac
Z-Stack™ Software	ZigBee® protocol stack	www.ti.com/z-stack
RemoTI™ Software	ZigBee RF4CE protocol stack	www.ti.com/remoti
BLEstack	*Bluetooth*® low energy protocol stack	www.ti.com/blestack
Bluetooth® Stack	Stonestreet One Bluetopia *Bluetooth*® Stack	www.ti.com/bluetoothstack
AM37x Linux SDK	Linux Open-Source Wi-Fi® & BlueZ *Bluetooth*® Stack, Drivers & Demos	processors.wiki.ti.com/index.php/AM37x_release_download_page
DM37x Linux SDK	Linux Open-Source Wi-Fi & BlueZ *Bluetooth*® Stack, Drivers & Demos	TBD
AM18x Linux SDK	Linux Open-Source Wi-Fi & BlueZ *Bluetooth*® Stack, Drivers & Demos	processors.wiki.ti.com/index.php/AM18x_release_download_page
OMAP-L138 Linux SDK	Linux Open-Source Wi-Fi Stack, Drivers & Demos	processors.wiki.ti.com/index.php/OMAPL138_DVSDK_download_page
AM335x Linux SDK	Linux Open-Source Wi-Fi & BlueZ *Bluetooth*® Stack, Drivers & Demos	processors.wiki.ti.com/index.php/AM335x_release_download_page
AM37x Android ADK	Wi-Fi & *Bluetooth*® support integrated with Android™ Framework	processors.wiki.ti.com/index.php/AM37x_release_download_page
AM335x Android ADK	Wi-Fi & *Bluetooth*® support integrated with Android Framework	processors.wiki.ti.com/index.php/AM335x_release_download_page

Software Tools/Resources

Name	Description	Web link
SmartRF™ Studio	Applications for controlling the RF ICs from the PC and to find appropriate register settings for the radio	www.ti.com/smartrfstudio
SmartRF Packet Sniffer	Sample packet sniffer application. Communicates with an evaluation board with a radio that captures packets on the specified channel. The sniffer GUI parses and displays the packets.	www.ti.com/packetsniffer
SmartRF Flash Programmer	Use this applications to program hex files on the System-on-Chip (SoC) or to update the firmware on the Evaluation Boards	See tool folder of your preferred SoC part
Example Libraries	The example libraries include the most basic functionality needed to establish a link between two devices	See tool folder of your preferred SoC part
USB Libraries	USB interface libraries for devices with built-in USB interface (CC2511, CC1111, CC2531)	See tool folder of your preferred SoC part
MSP430 Code Library for Low-Power RF	The code library provides functions to facilitate the interfacing of an MSP430 MCU to CC1100/2500 RF IC	www.ti.com/ccmsplib
PurePath™ Wireless Configurator	Use this graphical PC tool for programming of CC85xx devices	www.ti.com/ppwc
PurePath Wireless Commander	Run tests for evaluating performances of CC85xx devices	See tool folder of your preferred SoC part
SimpleLink™ CC4000 GPS Drivers	Firmware and demosoftware for out-of-the-box experience demo	www.ti.com/tool/cc4000gpsem

Low-power RF application notes and design notes

Low-power RF can provide you with more than 100 application notes and design notes. Find them on the Wireless Connectivity products web pages in the related literature. You will then get device specific documentation. To access any of the application notes and design notes, type the URL: *www.ti.com/wirelessconnectivity* and then go to the documents tab and use the search engine to find the right information you need.

Texas Instruments Design Network (TIDN)

The TI Design Network for low-power RF developers, Wi-Fi® and *Bluetooth*® dual-mode is a worldwide community of respected, experienced, and well-established companies including those servicing the low-power RF market in the sub-1-GHz and 2.4-GHz ISM frequency bands and the 2.4-GHz wireless technologies market for Wi-Fi and *Bluetooth*.

This network consists of recommended companies, RF consultants and independent design houses that provide scalable projects from antenna circuit-board layout to turnkey system design and FCC or ETSI compliance testing.

Benefits include:

- A faster design-to-production schedule and experience with the TI Low-power RF product portfolio
- RF circuit, low-power RF and ZigBee® design services
- Low-power RF and ZigBee module solutions
- Development tools for testing and troubleshooting RF systems
- RF certification services and RF circuit manufacturing
- Online search tool to determine suitable RF development partners

To find a suitable partner for your design and test project go to:

www.ti.com/lprfnetwork for ZigBee, sub-1 GHz, *Bluetooth* low energy and other proprietary wireless technologies

www.ti.com/tidn for Wi-Fi and *Bluetooth* 4.0 technologies

Are you interested in becoming a TI development partner?
Send an e-mail to ***m.grazier@ti.com*** for more information.

Featured third-party developers

Europe

Amber Europe:
Amber Wireless GmbH is a German electronics company specializing in the design, manufacturing and marketing of compact short range radio modules and modems for rapid implementation of cable-free data links and have become one of the leading suppliers for ISM/SRD radio modules and radio modems in Europe.

Wireless connectivity ICs:
CC430, CC1101, CC2520, CC2530

Contact details:
Contact: Wolfgang Esch
E-mail: wolfgang.esch@amber-wireless.de
Phone: 0049-2203-6991950
URL: http://www.amber-wireless.de/

Radiocrafts:
Radiocrafts designs, manufactures and markets standard RF modules for operation in the license-free ISM bands at 315 / 433 / 429 / 868 / 915 MHz and 2.4 GHz.

Low-Power RF ICs:
CC2420, CC1020, CC2430, CC2431, CC2400, CC1000, CC2530

Contact details:
Contact: Peder Martin Evjen
E-mail: radiocrafts@radiocrafts.com
Phone: (+47) 4000 5195
URL: http://www.radiocrafts.com

Sensinode 6LowPAN:
Sensinode is the pioneer IP-based wireless sensor network solution provider and offers seamless Internet integration to embedded device and chip manufacturers through all industries on a worldwide level.

Wireless connectivity ICs:
CC2430, CC1100, CC1110

Contact details:
Phone: +358 10 387 8680
URL: www.sensinode.com

United States

LS Research:
L.S. Research provides complete design services for product development including embedded firmware, RF design, antenna design, analog/digital design, PCB layout, and prototyping. L.S. Compliance provides FCC, CE, and ETSI testing services.

Wireless connectivity ICs
CC2530, CC2500, CC2550, CC2510, CC1100, CC1110, CC2511, CC256x, CC1020, CC2520/MSP430, WL1271-TiWi, CC3000-TiWi

Contact details:
Contact: Bill Steinike
E-mail: bsteinike@lsr.com
Phone: 262-375-4400 ext.103
URL: http://www.lsr.com/

Anaren:
Anaren (Nasdaq: ANEN) is a US-based global innovator of microwave/RF technology for the space, defense, wireless infrastructure, and consumer electronics sectors. As part of TI's Low-power RF network, the company offer its Anaren Integrated Radio (AIR) module family – compact, pre-certified, SMT radio modules eOEMs can quickly and cost-effectively implement without deep RF expertise and operate at 433MHz, 868MHz, 900MHz, and 2.5GHz. (AIR-equipped test boards available for use with TI EZ430 and DK tools.)

Wireless connectivity ICs:
CC1101, CC2500, CC8520 PurePath™ uncompressed wireless audio w/ CC2591 range extender; test boards

Contact details:
Contact: Mark Bowyer
E-mail: mbowyer@anaren.com or AIR@anaren.com
Phone: Toll free in US: 800.411.6596 or 44-2392-232392 (in Europe)
URL: www.anaren.com

Awarepoint:
Awarepoint is providing its Real-Time Awareness Solutions® to healthcare clients that include prestigious teaching institutions, premiere independents, military facilities and members of major integrated delivery networks.

Wireless connectivity ICs:
CC2430, CC2431

Contact details:
Toll-Free: 1-888-860-FIND (888-860-3463)
Phone: (858) 345-5000
URL: www.awarepoint.com

Panasonic:
Panasonic Electronic Components provides powerful, highly flexible, cost effective RF modules for a wide variety of wireless Personal Area Network applications, while also specializing in contract manufacturing and design services.

Wireless connectivity ICs
CC2560-PAN1325/15, CC2564-PAN1326/16
CC2567-PAN1327/17

Contact details:
URL: http://www.panasonic.com/ti

Pacific Design Engineering:
PDE provides complete product design services including; Wi-Fi applications development, Android and iOS development, RF design, antenna design, embedded firmware, microcontroller design, analog/digital design, mechanical and industrial design, PCB layout, and prototyping.

Wireless connectivity ICs:
SimpleLink Wi-Fi CC3000, CC2400, CC2500, CC2520/MSP430, CC2530, CC2540, CC2541, CC2591, CC8520 PurePath CC1100, CC1110, CC1111, CC1190, CC430

Contact details:
Contact: Derek Pyner
E-mail: pyner@pde.com
Phone: (604) 421 1311 ext 20
Toll Free: (800) 561 3322
URL: http://www.pde.com

Global Navigation systems GNS – GmbH:
GNS-GmbH is a German electronics company. GNS production complies with ISO 9001. GNS provides complete design services, software IP, RF design, PCB layout , prototyping, testing and manufacturing of GPS only and GPS combo modules. GNS also provides Software IP for GPS, BT, BLE, and FM / TMC based on different OS like Android, Linux, Windows, WIN CE

Wireless connectivity ICs:
CC4000, NL5500, NL5500L, MSP430

Contact details:
Contact: Werner Koch
E-mail: w.koch@gns-gmbh.com
Phone: 0049-2405-4148-16
URL: http://www.gns-gmbh.com

Murata:
Murata is a global leader in the manufacture of electronic components including wireless connectivity modules. Wireless modules are world class in terms of size, production capacity, and quality.

Wireless connectivity ICs
WL127x, WL128x, WL18xx, CC2560, CC3000

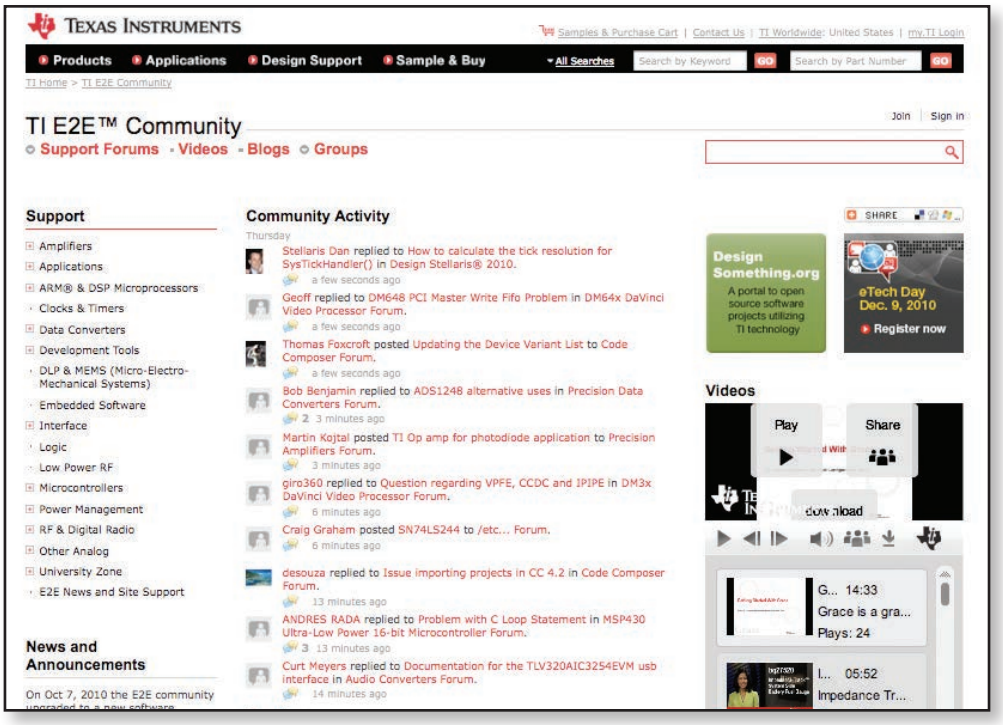
Contact details:
E-mail: modules@murata.com
URL: www.murata-ws.com

TI E2E™ Online Community

TI's Online Community has been created to provide you with technical support forums, videos and blogs, and the chance to openly and freely interact with fellow engineers.

With the Online Community you can:

- **Exchange** ideas, share knowledge and ask questions
- **View** our latest videos covering basic knowledge to deep technical content
- **Interact** with fellow engineers from all over the world



Join the E2E Online Community

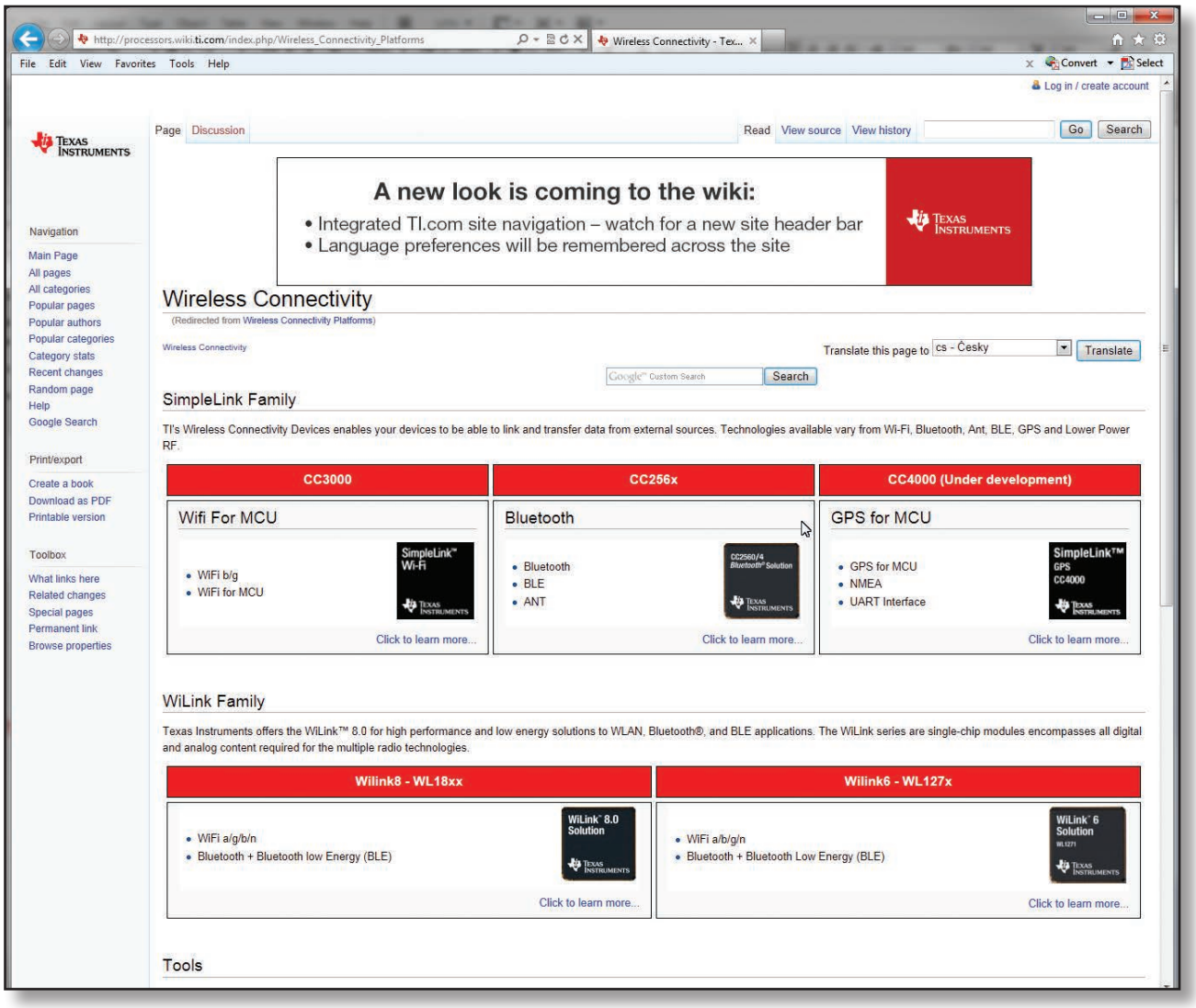
TI Connectivity Wiki

http://processors.wiki.ti.com/index.php/Wireless_Connectivity_Platforms

TI's Wireless Connectivity Wiki provides the latest and most comprehensive technical information needed to begin developing a wireless application.

With the Wireless Wiki you can:

- **Discover** User guides, sample applications, software
- **Learn** about the diverse catalog of available platforms
- **Clarify** your understanding with support links for all wireless technologies



TI Worldwide Technical Support

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TI Semiconductor Product Information Center Home Page
support.ti.com

TI E2E™ Community Home Page
e2e.ti.com

Product Information Centers

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Mexico	Phone	0800-670-7544
	Fax	+1(972) 927-6377
	Internet/E-mail	support.ti.com/sc/pic/americas.htm

Europe, Middle East, and Africa
Phone

European Free Call	00800-ASK-TEXAS (00800 275 83927)
International	+49 (0) 8161 80 2121
Russian Support	+7 (4) 95 98 10 701

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Fax	+(49) (0) 8161 80 2045
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Direct E-mail	asktexas@ti.com

Japan

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	Domestic	0120-81-0036
Internet/E-mail	International	support.ti.com/sc/pic/japan.htm
	Domestic	www.tij.co.jp/pic

Asia
Phone

International	+91-80-41381665
Domestic	Toll-Free Number

Note: Toll-free numbers do not support mobile and IP phones.

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Hong Kong	800-96-5941
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Korea	080-551-2804
Malaysia	1-800-80-3973
New Zealand	0800-446-934
Philippines	1-800-765-7404
Singapore	800-886-1028
Taiwan	0800-006800
Thailand	001-800-886-0010

Fax	+8621-23073686
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